MAG Rainfall Intensity Proposal

Proposal to revise design rainfall intensity for the purposes of designing roof drainage systems using the State Plumbing Code.

Exhibit A	Appendix D to the 1994 UPC
Exhibit B	Arizona Administrative Code R4-48-122
Exhibit C	Excerpts from Chapter 11, 2000 UPC
Exhibit D	Excerpts from Chapter 11, 2003 IPC
Exhibit E	Section 1503.4, Roof Drainage from the 2003 IBC
Exhibit F	50-year Rainfall Record, Western Regional Climate Center Website
Exhibit G	Probability of 6" daily Rainfall, Western Regional Climate Center Website
Exhibit H	MAG Policy Statement on Roof Drainage, dated September 18, 1985

Proposal: Change the design rate of rainfall for the purposes of sizing rainwater piping from 6 inches per hour to 3 inches per hour.

Reasons:

- State Plumbing Code (1994 UPC, amended) section D.3.1 states that local rainfall figures are to determine maximum rainfall per hour.
- Local historical rainfall figures do not support the design rainfall intensity figure of 6 inches per hour (Exhibits F and G)
- Later editions of Plumbing Codes list rainfall figures in inches per hour using a 100-year return period of 2.2 (Exhibit C, Appendix D of 2000 UPC) or 2.5 (Exhibit D, Appendix B of the 2003 IPC).
- State Plumbing Code requires that overflow drains shall be provided, and that such overflow drains shall be independent from the primary roof drains
- There is no charging language in the State Plumbing Code amendments (Exhibit B) that mandate a 6" per hour design rainfall intensity.
- The issue of ponding addressed in the MAG Policy Statement (Exhibit H) can be addressed by means other than the assignment of an overly conservative rainfall intensity figure (See Section 1101.7 of Exhibit D).

NOTE: The figure of 3 inches per hour was chosen to cover all Maricopa County jurisdictions using the map and data provided in Exhibit D. The 3 inches per hour figure results in a conservative design figure for most MAG jurisdictions, but allows for ease of use of the plumbing code sizing tables, avoiding the need for excess interpolation or calculations.

(d) Overflow drains shall be the same size as the roof drains with the inlet flow line two (2) inches (51 mm) above the low point of the roof and shall be installed independent from the roof drains.

Part B
Roof Drains

D 2 Materials

Roof drains shall be of cast iron, copper, lead, or other corrosion resisting material.

D 2.1 Strainers

(a) Roof drains shall be equipped with strainers extending not less than four (4) inches (101.6 mm) above the surface of the roof immediately adjacent to the drain. Strainers shall have minimum inlet area one and one-half (1-1/2) times the pipe to which it is connected.

(b) Roof deck strainers for use on sun decks, parking decks, and similar occupied areas may be of an approved flat-surface type which is level with the deck. Such drains shall have an inlet area not less than two (2) times the area of the pipe to which the drain is connected.

(c) Roof drains passing through the roof into the interior of a building shall be made watertight at the roof line by the use of a suitable flashing material.

Part C
Sizing of Rainwater Piping

D 3.1 Vertical rainwater piping shall be sized in accordance with Table D-1. Table D-1 is based upon maximum inches (mm) of rainfall per hour falling upon a given roof area in square feet (m^2). Consult local rainfall figures to determine maximum rainfall per hour.

D 3.2 Vertical Wall Areas

Where vertical walls project above a roof so as to permit storm water to drain to the roof area below the adjacent roof area may be computed from Table D-1 as follows:

(a) For one (1) wall – add fifty (50) percent of the wall area to the roof area figures.

(b) For two (2) adjacent walls – add thirty-five (35) percent of the total wall areas.

(c) Two (2) walls opposite of same heights – add no additional area.

(d) Two (2) walls opposite of differing heights – add fifty (50) percent of wall area above top of lower wall.

(e) Walls on three (3) sides – add fifty (50) percent of area of the inner wall below the top of the lowest wall, plus allowance for area of wall above top of lowest wall per (b) and (d).

(f) Walls on four (4) sides – no allowance for wall areas below top of lowest wall – add for areas above top of lowest wall per (a), (b), (d), and (e).

Exhibit B

Table A. Plumbing Material Standards

Materials and Products	ANSI	ASTM	FS	IAPMO	Other Standards	Footnote Remarks
NONMETALLIC PIPE: Crosslinked Polyethylene-Aluminum-Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe		F1281-01e1 *		C-3388	NSF 14 NSF 61	
Polyethylene-Aluminum-Polyethylene (PE-AL-PE) Pressure Pipe		F1282-02e1 *		C-3389	NSF 14 NSF 61	
Metal insert fittings for Polyethylene-Aluminum-Polyethylene (PE-AL-PE) and Crosslinked Polyethylene-Aluminum-Crosslinked Polyethylene (PEX-AL-PEX) Composite Pressure Pipe		F1974-01e1 *		C-3846	NSF 14 NSF 61	
NONMETALLIC PIPE: Metal insert fittings utilizing a copper crimp ring for SDR9 Cross-Linked Polyethylene (PEX) tubing. Cold Expansion Fitting with PEX reinforcing ring for use with SDR-9 Cross-Linked Polyethylene (PEX Tubing)		F1807-97 F1960-99				
PLUMBING FIXTURES: Waterless Urinals	Z124.9			C-3346		
Note: * Published by the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.						

Historical Note
New Table A made by final rulemaking at 7 A.A.R. 4329, effective September 9, 2001 (Supp. 01-3). Amended by final rulemaking at 9 A.A.R. 1189, effective May 18, 2003 (Supp. 03-1).

R4-48-115. Reserved

R4-48-116. Reserved

R4-48-117. Reserved

R4-48-118. Reserved

R4-48-119. Appendix A, Recommended Rules for Sizing the Water Supply System
This appendix has no modifications.

Historical Note
New Section made by final rulemaking at 7 A.A.R. 4329, effective September 9, 2001 (Supp. 01-3).

R4-48-120. Appendix B, Explanatory Notes on Combination Waste and Vent Systems
This appendix has no modifications.

Historical Note
New Section made by final rulemaking at 7 A.A.R. 4329, effective September 9, 2001 (Supp. 01-3).

R4-48-121. Appendix C, Minimum Plumbing Facilities
The Uniform Plumbing Code incorporated in R4-48-102(A) is modified as follows:

The third paragraph of Appendix C is added to read: "Those jurisdictions that have not adopted a building code which stipulates minimum plumbing facilities shall utilize Appendix C of the 1994 UPC when establishing plumbing facility requirements.

Historical Note
New Section made by final rulemaking at 7 A.A.R. 4329, effective September 9, 2001 (Supp. 01-3).

R4-48-122. Appendix D, Rainwater Systems
The Uniform Plumbing Code incorporated in R4-48-102(A) is modified as follows:

1. Appendix D 1 (a) is modified to read:
   Rainwater piping placed within the interior of a building or run within a vent or shaft shall be of cast iron, galvanized steel, wrought iron, brass, copper, lead, Schedule 40 ABS DWV, Schedule 40 PVC DWV, or other approved materials, and changes in direction shall conform to the requirements of Section 706.0.
2. Appendix D1.1(c) is modified to read: Roof drains, overflow drains, and rainwater piping installed within the building shall be tested in conformity with the provisions of this Code for testing drain, waste, and vent systems.
3. Appendix D3.3 is modified to read: Horizontal Rainwater Piping. Horizontal Rainwater Piping shall be sized in accordance with Table D-2. Exception: The potential head of water which may rise in the vertical drain pipe (tailpiece) may be used to reduce the horizontal pipe size and its slope if the head (rise) is sufficient when calculated as follows:
   (a) If the head ('h') is equal to or greater than 3/8 inch for each foot (31.35 mm/m) of horizontal pipe length, the horizontal pipe may be pitched at 1/8 inch slope (10.45 mm/m), but sized according to the 1/2 inch slope (41.8 mm/m) table.
   (b) If the head ('h') is equal to or greater than 1/8 inch for each foot (10.45 mm/m) of horizontal pipe length, the horizontal pipe may be pitched at 1/8 inch slope (10.45 mm/m), but sized according to the 1/4 inch slope (20.9 mm/m) table. (See Illustration A).
   EXAMPLE #1: Roof Area – 4800 Square Feet (445.9 m 2)
   Maximum Rainfall/Hour - Six Inches (152.4 mm/h)
   Pipe Laid at 1/8 inch Slope (10.45 mm/m)
   Using the 1/2 inch slope (41.8 mm/m) table, the horizontal pipe size will be six inches.
   The available static head ('h') needed to allow use of the 1/2 inch (41.8 mm/m) table is calculated as follows:
   3/8 inch of head pressure per foot (31.35 mm/m) of horizontal pipe run becomes 3/8-inch x 100 feet

= 300/8ths, or 'h' = 37 1/2 inches (952.5 mm). NOTE: Sizing from the 1/8 inch (10.45 mm per m) table would have required the horizontal pipe size to be eight inches (203.2 mm), rather than the six inches (152.4 mm) made possible by use of the 1/2 inch (41.8 mm/m) slope table.

EXAMPLE #2: Roof Area – 6000 Square Feet
Maximum Rainfall/Hour – six Inches (152.4 mm)
Pipe Laid at 1/8 inch Slope (10.45 mm/m)

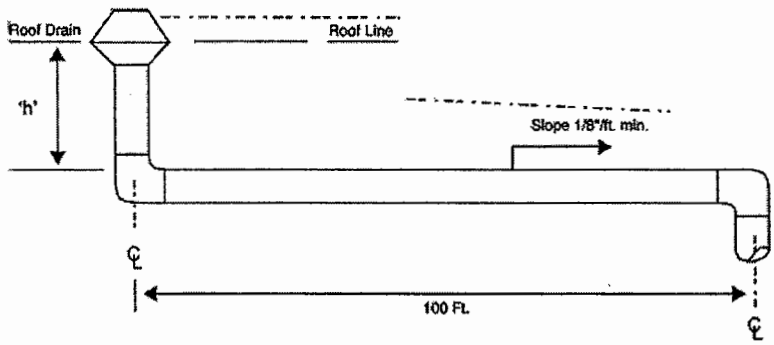
Using the 1/4 inch slope (20.9 mm/m) table the horizontal pipe size will be eight inches (203.3 mm). The available static head ('h') needed to allow use of the 1/4 inch (20.9 mm/m) table is calculated as follows: 1/8 inch of head pressure per foot (10.45 mm per m) of horizontal pipe run becomes 1/8-inch x 100 feet = 100/8ths, or 'h' = 121/2 inches (317.5 mm). NOTE: Sizing from 1/8 inch (10.45 mm per m) table would have required the horizontal pipe size to be 10 inches (254.0 mm) rather than the eight inches (203.2 mm) made possible by use of the1/4 inch slope (20.9 mm/m) table.

(c) If the head ('h') is equal to or greater than 10 feet (3.05 m) (for example, base of a stack), all horizontal pipe downstream of any such vertical section may be the same size as the vertical pipe to which it is connected.

Historical Note

New Section made by final rulemaking at 7 A.A.R. 4329, effective September 9, 2001 (Supp. 01-3). Amended by final rulemaking at 9 A.A.R. 1189, effective May 18, 2003 (Supp. 03-1).

Illustration A. Horizontal Rainwater Piping



Historical Note

New Illustration A made by final rulemaking at 7 A.A.R. 4329, effective September 9, 2001 (Supp. 01-3).

R4-48-123. Appendix E, Manufactured or Mobile Home Parks and Recreational Vehicle Parks

This appendix has no modifications.

Historical Note

New Section made by final rulemaking at 7 A.A.R. 4329, effective September 9, 2001 (Supp. 01-3).

R4-48-124. Appendix F, Medical Gas Systems

The Uniform Plumbing Code incorporated in R4-48-102(A) is modified as follows:

1. Appendix F Medical Gas Systems. Current language is deleted and replaced with the following sections of NFPA #99, Health Care Facilities (1996 Edition) as amended by this section, which are incorporated by reference. The incorporation by reference does not include any later amendments or editions. Copies of the incorporated material are available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02169, and are on file with the Office of the Secretary of State:

F1 Scope

(a) The provisions herein shall apply to the installation, testing, and certification of medical gas and vacuum piping for safe use in-patient care hospitals, clinics, and other health care facilities.

(b) The purpose of this appendix is to provide minimum requirements for the installation, testing, and certification of medical gas and medical vacuum systems, from the point of supply to the user outlets or inlets. These provisions do no cover portable systems or cylinder storage requirements.

F2 All medical gas and vacuum piping systems are to be installed and inspected based upon applicable language found in the following chapters of NFPA #99, Health Care Facilities (1996 edition):

Chapter 1. Introduction.
1-1 Scope
1-2 Application. (Use first paragraph; delete second paragraph)
1-3 Intended Use
1-4 Discretionary Powers of Authority Having Jurisdiction
1-5 Interpretations
1-6 Organization of This Document (subsections 1-6.1, 1-6.2, and 1-6.3)
1-7 Metric Units
1-8 Effective Date
1-9 Preface
Add Sec. 1-10 to read: Sections of NFPA 99, 1996 edition, which are not referenced are not mandated by the Arizona Uniform Plumbing Code.

Chapter 2. Definitions.
2-1 Official NFPA Definitions

1101.6 Building Subdrains. Building subdrains located below the public sewer level shall discharge into a sump or receiving tank, the contents of which shall be automatically lifted and discharged into the drainage system as required for building sumps.

1101.7 Areaway Drains. All open subsurface space adjacent to a building, serving as an entrance to the basement or cellar of a building, shall be provided with a drain or drains. Such areaway drains shall be two (2) inches (50 mm) minimum diameter for areaways not exceeding one hundred (100) square feet (9.3 m²) in area, and shall be discharged in the manner provided for subsoil drains not serving continuously flowing springs or ground water (see Section 1101.5.2). Areaways in excess of one hundred (100) square feet (9.3 m²) shall not drain into subsoil. Areaway drains for areaways exceeding one hundred (100) square feet (9.3 m²) shall be sized according to Table 11-2.

1101.8 Window Areaway Drains. Window areaways not exceeding ten (10) square feet (0.9 m²) in area may discharge to the subsoil drains through a two (2) inch (50 mm) pipe. However, window areaways exceeding ten (10) square feet (0.9 m²) in area shall be handled in the manner provided for entrance areaways (see Section 1101.7).

1101.9 Filling Stations and Motor Vehicle Washing Establishments. Public filling stations and motor vehicle washing establishments shall have the paved area sloped toward sumps or gratings within the property lines. Curbs not less than six (6) inches (152 mm) high shall be placed where required to direct water to gratings or sumps.

1101.10 Paved Areas. Where the occupant creates surface water drainage, the sumps, gratings or floor drains shall be piped to a storm drain or an approved water course.

1101.11 Roof Drainage

1101.11.1 Primary Roof Drainage. Roof areas of a building shall be drained by roof drains or gutters. The location and sizing of drains and gutters shall be coordinated with the structural design and pitch of the roof. Unless otherwise required by the Administrative Authority, roof drains, gutters, vertical conductors or leaders, and horizontal storm drains for primary drainage shall be sized based on a storm of sixty (60) minutes duration and 100-year return period (see Appendix D).

1101.11.2 Secondary Roof Drainage

1101.11.2.1 Where parapet walls or other construction extend above the roof and create areas where storm water would become trapped if the primary roof drainage system failed to provide sufficient drainage, an independent secondary roof drainage system consisting of scuppers, standpipes, or roof drains shall be provided. Secondary roof drainage systems shall be sized in accordance with Section 1101.11.1 of this Code. Overflow drains shall be the same size as the roof drains with the inlet flow line two (2) inches (51 mm) above the low point of the roof and shall be installed independent from the roof drains.

1101.11.2.2 Where secondary roof drainage is provided by means of roof drains or standpipes, the secondary system shall be separate from the primary system and shall discharge independently at grade or other approved point of discharge.

1101.11.2.3 Where secondary roof drainage is provided, the overflow level(s) into the secondary system shall be determined by the structural design of the roof, including roof deflection, at a level not less than two (2) inches (51 mm) above the level of the primary drain. An allowance shall be made to account for the required overflow head of water above the secondary inlets. The elevation of the secondary inlet plus the required overflow head shall not exceed the maximum allowable water level on the roof.

1101.11.2.4 Scuppers shall be sized as rectangular weirs, using hydraulic principles to determine the required length and resulting overflow head (see Appendix D). Secondary roof drains and standpipes shall be sized according to Table 11-1. Where standpipes are used, the head allowance required under section 1101.11.2.3 shall be not less than one and one-half (1-1/2) inches (38 mm).

1101.11.3 Equivalent Systems. When approved by the Administrative Authority, the requirements of Sections 1101.11.1 and 1101.11.2 shall not preclude the installation of an engineered roof drainage system that has sufficient capacity to prevent water from ponding on the roof in excess of that allowed in the roof structural design with a rainfall rate of at least twice that for a 100-year, 60-minute storm and with a blockage in any single point in the storm drainage system.

1101.12 Cleanouts

1101.12.1 Cleanouts for building storm drains shall comply with the requirements of Section 719.0 of this Code.

C

2000 UPC

APPENDIX D

SIZING STORMWATER DRAINAGE SYSTEMS

D 1 Roof Drainage

The rainfall rates in Table D-1 should be used for design unless higher values are established locally.

TABLE D-1
Maximum Rates of Rainfall for Various Cities

The rainfall rates in this table are based on U.S. Weather Bureau Technical Paper No. 40, Chart 14: 100-Year 60-Minute Rainfall (inches).

States and Cities	Storm Drainage 60-Minute Duration, 100-Year Return	
	Inches/Hour	GPM/Square Foot
ALABAMA		
Birmingham	3.7	0.038
Huntsville	3.3	0.034
Mobile	4.5	0.047
Montgomery	3.8	0.039
ALASKA		
Aleutian Islands	1.0	0.010
Anchorage	0.6	0.006
Bethel	0.8	0.008
Fairbanks	1.0	0.010
Juneau	0.6	0.006
ARIZONA		
Flagstaff	2.3	0.024
Phoenix	2.2	0.023
Tucson	3.0	0.031
ARKANSAS		
Eudora	3.8	0.039
Ft. Smith	3.9	0.041
Jonesboro	3.5	0.036
Little Rock	3.7	0.038
CALIFORNIA		
Eureka	1.5	0.016
Lake Tahoe	1.3	0.014
Los Angeles	2.0	0.021
Lucerne Valley	2.5	0.026
Needles	1.5	0.016
Palmdale	3.0	0.031
Redding	1.5	0.016
San Diego	1.5	0.016
San Francisco	1.5	0.016
San Luis Obispo	1.5	0.016

Exhibit 2003 IPC

D

1102.7 Fittings. Pipe fittings shall be approved for installation with the piping material installed, and shall conform to the respective pipe standards or one of the standards listed in Table 1102.7. The fittings shall not have ledges, shoulders or reductions capable of retarding or obstructing flow in the piping. Threaded drainage pipe fittings shall be of the recessed drainage type.

TABLE 1102.7
PIPE FITTINGS

MATERIAL	STANDARD
Acrylonitrile butadiene styrene (ABS) plastic	ASTM D 2468; ASTM D 2661
Cast-iron	ASME B16.4; ASME B16.12; ASTM A 888; CISPI 301; ASTM A 74
Chlorinated polyvinyl chloride (CPVC) plastic	ASTM F 437; ASTM F 438; ASTM F 439
Copper or copper alloy	ASME B16.15; ASME B16.18; ASME B16.22; ASME B16.23; ASME B16.26; ASME B16.29
Gray iron and ductile iron	AWWA C110
Malleable iron	ASME B16.3
Plastic, general	ASTM F 409
Polyethylene (PE) plastic	ASTM D 2609
Polyvinyl chloride (PVC) plastic	ASTM D 2464; ASTM D 2466; ASTM D 2467; CSA-B137.2; ASTM D 2665; ASTM F 1866
Steel	ASME B16.9; ASME B16.11; ASME B16.28
Stainless steel drainage Systems, Type 316L	ASME A112.3.1

SECTION 1103
TRAPS

1103.1 Main trap. Leaders and storm drains connected to a combined sewer shall be trapped. Individual storm water traps shall be installed on the storm water drain branch serving each conductor, or a single trap shall be installed in the main storm drain just before its connection with the combined building sewer or the public sewer.

1103.2 Material. Storm water traps shall be of the same material as the piping system to which they are attached.

1103.3 Size. Traps for individual conductors shall be the same size as the horizontal drain to which they are connected.

1103.4 Cleanout. An accessible cleanout shall be installed on the building side of the trap.

SECTION 1104
CONDUCTORS AND CONNECTIONS

1104.1 Prohibited use. Conductor pipes shall not be used as soil, waste or vent pipes, and soil, waste or vent pipes shall not be used as conductors.

1104.2 Combining storm with sanitary drainage. The sanitary and storm drainage systems of a structure shall be entirely separate except where combined sewer systems are utilized. Where a combined sewer is utilized, the building storm drain shall be connected in the same horizontal plane through a single-wye fitting to the combined sewer at least 10 feet(3048 mm) downstream from any soil stack.

1104.3 Floor drains. Floor drains shall not be connected to a storm drain.

SECTION 1105
ROOF DRAINS

1105.1 Strainers. Roof drains shall have strainers extending not less than 4 inches (102 mm) above the surface of the roof immediately adjacent to the roof drain. Strainers shall have an available inlet area, above roof level, of not less than one and one-half times the area of the conductor or leader to which the drain is connected.

1105.2 Flat decks. Roof drain strainers for use on sun decks, parking decks and similar areas that are normally serviced and maintained shall comply with Section 1105.1 or shall be of the flat-surface type, installed level with the deck, with an available inlet area not less than two times the area of the conductor or leader to which the drain is connected.

1105.3 Roof drain flashings. The connection between roofs and roof drains which pass through the roof and into the interior of the building shall be made water tight by the use of approved flashing material.

SECTION 1106
SIZE OF CONDUCTORS, LEADERS AND STORM DRAINS

1106.1 General. The size of the vertical conductors and leaders, building storm drains, building storm sewers, and any horizontal branches of such drains or sewers shall be based on the 100-year hourly rainfall rate indicated in Figure 1106.1 or on other rainfall rates determined from approved local weather data.

1106.2 Vertical conductors and leaders. Vertical conductors and leaders shall be sized for the maximum projected roof area, in accordance with Table 1106.2.

1106.3 Building storm drains and sewers. The size of the building storm drain, building storm sewer and their horizontal branches having a slope of one-half unit or less vertical in 12 units horizontal (4-percent slope) shall be based on the maximum projected roof area in accordance with Table 1106.3. The minimum slope of horizontal branches shall be one-eighth unit vertical in 12 units horizontal (1-percent slope) unless otherwise approved.

Exhibit D 2003 IPC

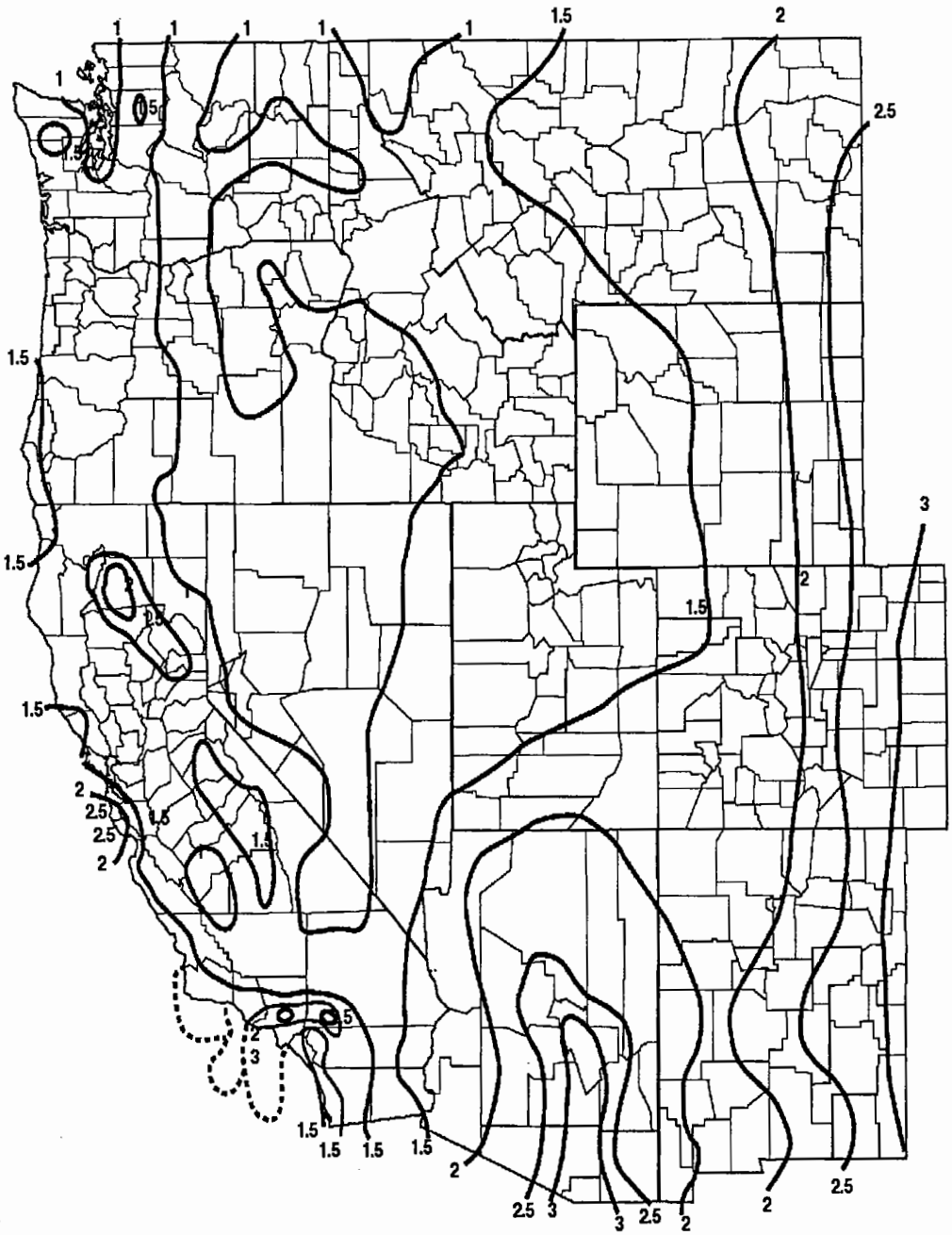


FIGURE 1106.1—continued
100-YEAR, 1-HOUR RAINFALL (INCHES)
WESTERN UNITED STATES

For SI: 1 inch = 25.4 mm.

Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington D.C.

Exhibit D - 2003 IPC

1107.2 Separate systems required. Secondary roof drain systems shall have the end point of discharge separate from the primary system. Discharge shall be above grade, in a location which would normally be observed by the building occupants or maintenance personnel.

1107.3 Sizing of secondary drains. Secondary (emergency) roof drain systems shall be sized in accordance with Section 1106 based on the rainfall rate for which the primary system is sized in Tables 1106.2, 1106.3 and 1106.6. Scuppers shall be sized to prevent the depth of ponding water from exceeding that for which the roof was designed as determined by Section 1101.7. Scuppers shall not have an opening dimension of less than 4 inches (102 mm). The flow through the primary system shall not be considered when sizing the secondary roof drain system.

SECTION 1108
COMBINED SANITARY AND STORM SYSTEM

1108.1 Size of combined drains and sewers. The size of a combination sanitary and storm drain or sewer shall be computed in accordance with the method in Section 1106.3. The fixture units shall be converted into an equivalent projected roof or paved area. Where the total fixture load on the combined drain is less than or equal to 256 fixture units, the equivalent drainage area in horizontal projection shall be taken as 4,000 square feet (372 m^2). Where the total fixture load exceeds 256 fixture units, each additional fixture unit shall be considered the equivalent of 15.6 square feet (1.5 m^2) of drainage area. These values are based on a rainfall rate of 1 inch (25 mm) per hour.

SECTION 1109
VALUES FOR CONTINUOUS FLOW

1109.1 Equivalent roof area. Where there is a continuous or semicontinuous discharge into the building storm drain or building storm sewer, such as from a pump, ejector, air conditioning plant or similar device, each gallon per minute (L/m) of such discharge shall be computed as being equivalent to 96 square feet (9 m^2) of roof area, based on a rainfall rate of 1 inch (25.4 mm) per hour.

SECTION 1110
CONTROLLED FLOW ROOF DRAIN SYSTEMS

1110.1 General. The roof of a structure shall be designed for the storage of water where the storm drainage system is engineered for controlled flow. The controlled flow roof drain system shall be an engineered system in accordance with this section and the design, submittal, approval, inspection and testing requirements of Section 105.4. The controlled flow system shall be designed based on the required rainfall rate in accordance with Section 1106.1.

1110.2 Control devices. The control devices shall be installed so that the rate of discharge of water per minute shall not exceed the values for continuous flow as indicated in Section 1109.1.

1110.3 Installation. Runoff control shall be by control devices. Control devices shall be protected by strainers.

1110.4 Minimum number of roof drains. Not less than two roof drains shall be installed in roof areas 10,000 square feet (930 m^2) or less and not less than four roof drains shall be installed in roofs over 10,000 square feet (930 m^2) in area.

SECTION 1111
SUBSOIL DRAINS

1111.1 Subsoil drains. Subsoil drains shall be open-jointed, horizontally split or perforated pipe conforming to one of the standards listed in Table 1102.5. Such drains shall not be less than 4 inches (102 mm) in diameter. Where the building is subject to backwater, the subsoil drain shall be protected by an accessibly located backwater valve. Subsoil drains shall discharge to a trapped area drain, sump, dry well or approved location above ground. The subsoil sump shall not be required to have either a gas-tight cover or a vent. The sump and pumping system shall comply with Section 1113.1.

SECTION 1112
BUILDING SUBDRAINS

1112.1 Building subdrains. Building subdrains located below the public sewer level shall discharge into a sump or receiving tank, the contents of which shall be automatically lifted and discharged into the drainage system as required for building sumps. The sump and pumping equipment shall comply with Section 1113.1.

SECTION 1113
SUMPS AND PUMPING SYSTEMS

1113.1 Pumping system. The sump pump, pit and discharge piping shall conform to Sections 1113.1.1 through 1113.1.4.

1113.1.1 Pump capacity and head. The sump pump shall be of a capacity and head appropriate to anticipated use requirements.

1113.1.2 Sump pit. The sump pit shall not be less than 18 inches (457 mm) in diameter and 24 inches (610 mm) deep, unless otherwise approved. The pit shall be accessible and located such that all drainage flows into the pit by gravity. The sump pit shall be constructed of tile, steel, plastic, cast-iron, concrete or other approved material, with a removable cover adequate to support anticipated loads in the area of use. The pit floor shall be solid and provide permanent support for the pump.

1113.1.3 Electrical. Electrical service outlets, when required, shall meet the requirements of the ICC *Electrical Code*.

1113.1.4 Piping. Discharge piping shall meet the requirements of Section 1102.2, 1102.3 or 1102.4 and shall include a gate valve and a full flow check valve. Pipe and fittings shall be the same size as, or larger than, pump discharge tapping.

Exception: In one- and two-family dwellings, only a check valve shall be required, located on the discharge piping from the pump or ejector.

Exhibit D

APPENDIX B
RATES OF RAINFALL FOR VARIOUS CITIES

Rainfall rates, in inches per hour, are based on a storm of one-hour duration and a 100-year return period. The rainfall rates shown in the appendix are derived from Figure 1106.1.

Alabama:
- Birmingham 3.8
- Huntsville 3.6
- Mobile 4.6
- Montgomery 4.2

Alaska:
- Fairbanks 1.0
- Juneau 0.6

Arizona:
- Flagstaff 2.4
- Nogales 3.1
- Phoenix 2.5
- Yuma 1.6

Arkansas:
- Fort Smith 3.6
- Little Rock 3.7
- Texarkana 3.8

California:
- Barstow 1.4
- Crescent City 1.5
- Fresno 1.1
- Los Angeles 2.1
- Needles 1.6
- Placerville 1.5
- San Fernando 2.3
- San Francisco 1.5
- Yreka 1.4

Colorado:
- Craig 1.5
- Denver 2.4
- Durango 1.8
- Grand Junction 1.7
- Lamar 3.0
- Pueblo 2.5

Connecticut:
- Hartford 2.7
- New Haven 2.8
- Putnam 2.6

Delaware:
- Georgetown 3.0
- Wilmington 3.1

District of Columbia:
- Washington 3.2

Florida:
- Jacksonville 4.3
- Key West 4.3
- Miami 4.7
- Pensacola 4.6
- Tampa 4.5

Georgia:
- Atlanta 3.7
- Dalton 3.4
- Macon 3.9
- Savannah 4.3
- Thomasville 4.3

Hawaii:
- Hilo 6.2
- Honolulu 3.0
- Wailuku 3.0

Idaho:
- Boise 0.9
- Lewiston 1.1
- Pocatello 1.2

Illinois:
- Cairo 3.3
- Chicago 3.0
- Peoria 3.3
- Rockford 3.2
- Springfield 3.3

Indiana:
- Evansville 3.2
- Fort Wayne 2.9
- Indianapolis 3.1

Iowa:
- Davenport 3.3
- Des Moines 3.4
- Dubuque 3.3
- Sioux City 3.6

Kansas:
- Atwood 3.3
- Dodge City 3.3
- Topeka 3.7
- Wichita 3.7

Kentucky:
- Ashland 3.0
- Lexington 3.1
- Louisville 3.2
- Middlesboro 3.2
- Paducah 3.3

Louisiana:
- Alexandria 4.2
- Lake Providence . . . 4.0
- New Orleans 4.8
- Shreveport 3.9

Maine:
- Bangor 2.2
- Houlton 2.1
- Portland 2.4

Maryland:
- Baltimore 3.2
- Hagerstown 2.8
- Oakland 2.7
- Salisbury 3.1

Massachusetts:
- Boston 2.5
- Pittsfield 2.8
- Worcester 2.7

Michigan:
- Alpena 2.5
- Detroit 2.7
- Grand Rapids 2.6
- Lansing 2.8
- Marquette 2.4
- Sault Ste. Marie . . . 2.2

Minnesota:
- Duluth 2.8
- Grand Marais 2.3
- Minneapolis 3.1
- Moorhead 3.2
- Worthington 3.5

Mississippi:
- Biloxi 4.7
- Columbus 3.9
- Corinth 3.6
- Natchez 4.4
- Vicksburg 4.1

Missouri:
- Columbia 3.2
- Kansas City 3.6
- Springfield 3.4
- St. Louis 3.2

Montana:
- Ekalaka 2.5
- Havre 1.6
- Helena 1.5
- Kalispell 1.2
- Missoula 1.3

Nebraska:
- North Platte 3.3
- Omaha 3.8
- Scottsbluff 3.1
- Valentine 3.2

Nevada:
- Elko 1.0
- Ely 1.1
- Las Vegas 1.4
- Reno 1.1

New Hampshire:
- Berlin 2.5
- Concord 2.5
- Keene 2.4

New Jersey:
- Atlantic City 2.9
- Newark 3.1
- Trenton 3.1

New Mexico:
- Albuquerque 2.0
- Hobbs 3.0
- Raton 2.5
- Roswell 2.6
- Silver City 1.9

New York:
- Albany 2.5
- Binghamton 2.3
- Buffalo 2.3
- Kingston 2.7
- New York 3.0
- Rochester 2.2

North Carolina:
- Asheville 4.1
- Charlotte 3.7
- Greensboro 3.4
- Wilmington 4.2

North Dakota:
- Bismarck 2.8
- Devils Lake 2.9
- Fargo 3.1
- Williston 2.6

Ohio:
- Cincinnati 2.9
- Cleveland 2.6
- Columbus 2.8
- Toledo 2.8

Oklahoma:
- Altus 3.7
- Boise City 3.3
- Durant 3.8
- Oklahoma City 3.8

Oregon:
- Baker 0.9
- Coos Bay 1.5
- Eugene 1.3
- Portland 1.2

Exhibit E

1503.3 Coping. Parapet walls shall be properly coped with noncombustible, weatherproof materials of a width no less than the thickness of the parapet wall.

[P] 1503.4 Roof drainage. Design and installation of roof drainage systems shall comply with the *International Plumbing Code*.

1503.4.1 Gutters. Gutters and leaders placed on the outside of buildings, other than Group R-3 as applicable in Section 101.2, private garages and buildings of Type V construction, shall be of noncombustible material or a minimum of Schedule 40 plastic pipe.

1503.5 Roof ventilation. Intake and exhaust vents shall be provided in accordance with Section 1203.2 and the manufacturer's installation instructions.

SECTION 1504
PERFORMANCE REQUIREMENTS

1504.1 Wind resistance of roofs. Roof decks and roof coverings shall be designed for wind loads in accordance with Chapter 16 and Sections 1504.2, 1504.3 and 1504.4.

1504.1.1 Wind resistance of asphalt shingles. Asphalt shingles shall be designed for wind speeds in accordance with Section 1507.2.7.

1504.2 Wind resistance of clay and concrete tile. Clay and concrete tile roof coverings shall be connected to the roof deck in accordance with Chapter 16.

1504.3 Wind resistance of nonballasted roofs. Roof coverings installed on roofs in accordance with Section 1507 that are mechanically attached or adhered to the roof deck shall be designed to resist the design wind load pressures for cladding in Chapter 16.

1504.3.1 Other roof systems. Roof systems with built-up, modified bitumen, fully adhered or mechanically attached single-ply through fastened metal panel roof systems, and other types of membrane roof coverings shall also be tested in accordance with FM 4450, FM 4470, UL 580 or UL 1897.

1504.3.2 Metal panel roof systems. Metal panel roof systems through fastened or standing seam shall be tested in accordance with UL 580 or ASTM E 1592.

1504.4 Ballasted low-slope roof systems. Ballasted low-slope (roof slope < 2:12) single-ply roof system coverings installed in accordance with Section 1507 shall be designed in accordance with ANSI/SPRI RP-4.

1504.5 Edge securement for low-slope roofs. Low-slope membrane roof systems metal edge securement, except gutters, installed in accordance with Section 1507, shall be designed in accordance with ANSI/SPRI ES-1, except the basic wind speed shall be determined from Figure 1609.

1504.6 Physical properties. Roof coverings installed on low-slope roofs (roof slope < 2:12) in accordance with Section 1507 shall demonstrate physical integrity over the working life of the roof based upon 2,000 hours of exposure to accelerated weathering tests conducted in accordance with ASTM G 152, ASTM G 155 or ASTM G 154. Those roof coverings that are subject to cyclical flexural response due to wind loads shall not demonstrate any significant loss of tensile strength for unreinforced membranes or breaking strength for reinforced membranes when tested as herein required.

1504.7 Impact resistance. Roof coverings installed on low-slope roofs (roof slope < 2:12) in accordance with Section 1507 shall resist impact damage based on the results of tests conducted in accordance with ASTM D 3746, ASTM D 4272, CGSB 37-GP-52M or FM 4470.

SECTION 1505
FIRE CLASSIFICATION

1505.1 General. Roof assemblies shall be divided into the classes defined below. Class A, B and C roof assemblies and roof coverings required to be listed by this section shall be tested in accordance with ASTM E 108 or UL 790. In addition, fire-retardant-treated wood roof coverings shall be tested in accordance with ASTM D 2898. The minimum roof coverings installed on buildings shall comply with Table 1505.1 based on the type of construction of the building.

TABLE 1505.1[a,b]
MINIMUM ROOF COVERING CLASSIFICATION FOR TYPES OF CONSTRUCTION

IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB
B	B	B	C[c]	B	C[c]	B	B	C[c]

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2.

a. Unless otherwise required in accordance with the *International Urban Wildland Interface Code* or due to the location of the building within a fire district in accordance with Appendix D.

b. Nonclassified roof coverings shall be permitted on buildings of Group R-3, as applicable in Section 101.2, and Group U occupancies, where there is a minimum fire-separation distance of 6 feet measured from the leading edge of the roof.

c. Buildings that are not more than two stories in height and having not more than 6,000 square feet of projected roof area and where there is a minimum 10-foot fire-separation distance from the leading edge of the roof to a lot line on all sides of the building, except for street fronts or public ways, shall be permitted to have roofs of No. 1 cedar or redwood shakes and No. 1 shingles.

1505.2 Class A roof assemblies. Class A roof assemblies are those that are effective against severe fire test exposure. Class A roof assemblies and roof coverings shall be listed and identified as Class A by an approved testing agency. Class A roof assemblies shall be permitted for use in buildings or structures of all types of construction.

Exception: Class A roof assemblies include those with coverings of brick, masonry, slate, clay or concrete roof tile, exposed concrete roof deck, ferrous or copper shingles or sheets.

1505.3 Class B roof assemblies. Class B roof assemblies are those that are effective against moderate fire-test exposure. Class B roof assemblies and roof coverings shall be listed and identified as Class B by an approved testing agency.

Exception: Class B roof assemblies include those with coverings of metal sheets and shingles.

1505.4 Class C roof assemblies. Class C roof assemblies are those that are effective against light fire-test exposure. Class C roof assemblies and roof coverings shall be listed and identified as Class C by an approved testing agency.

Exhibit F

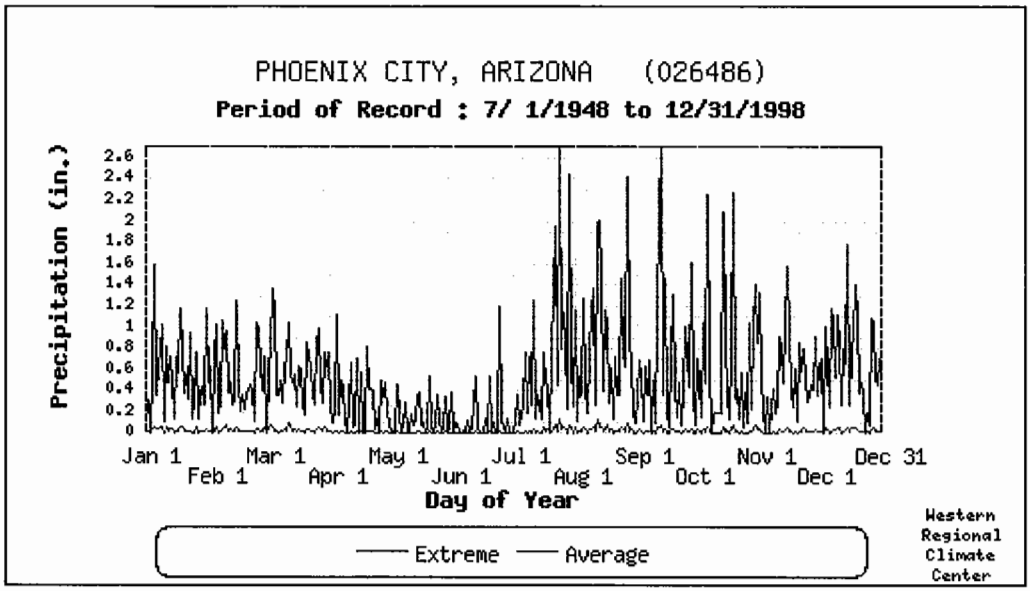

PHOENIX CITY, ARIZONA (026486)
Period of Record : 7/ 1/1948 to 12/31/1998
Precipitation (in.)
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Nov 1
Dec 1
Dec 31
Day of Year
Extreme
Average
Western Regional Climate Center

Exhibit G

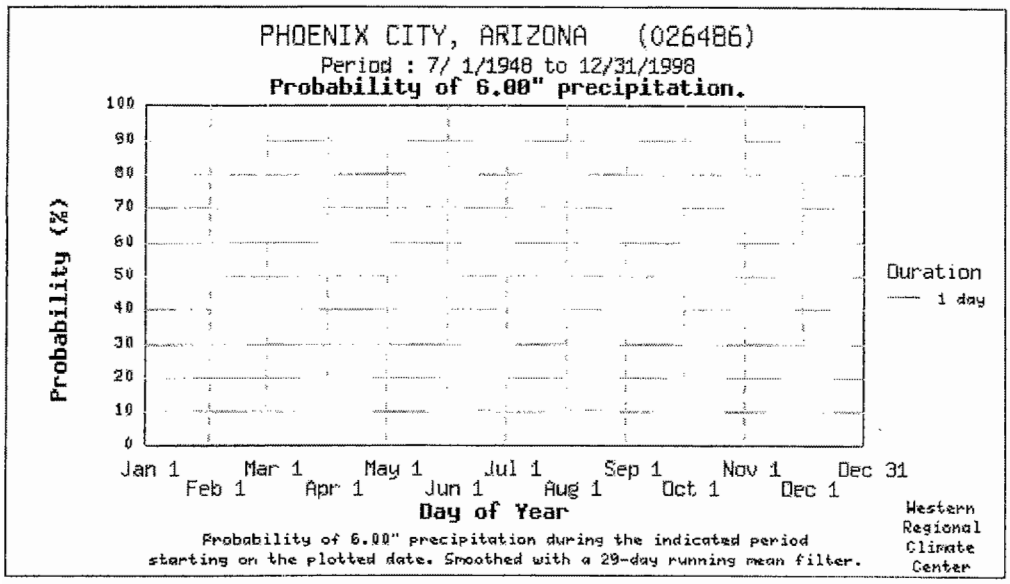

PHOENIX CITY, ARIZONA (026486)
Period : 7/ 1/1948 to 12/31/1998
Probability of 6.00" precipitation.
Probability (%)
100
90
80
70
60
50
40
30
20
10
0
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Nov 1
Dec 1
Dec 31
Day of Year
Duration
1 day
Probability of 6.00" precipitation during the indicated period
starting on the plotted date. Smoothed with a 29-day running mean filter.
Western
Regional
Climate
Center

Exhibit H (Page 1 of 2)

MARICOPA ASSOCIATION OF GOVERNMENTS

1820 WEST WASHINGTON PHOENIX, ARIZONA 85007 (602) 254-6308

September 18, 1985

TO: ALL MARICOPA ASSOCIATION OF GOVERNMENTS BUILDING DEPARTMENTS

FROM: MAG BUILDING CODES COMMITTEE

SUBJECT: POLICY STATEMENT-UPC REQUIREMENT-ROOF DRAINAGE

WATER ACCUMULATION

All roofs shall be designed with a primary slope of not less than ¼" per foot. Secondary slopes, such as valleys, crickets or sloping ledgers, shall be not less than 1/8" per foot to point of drainage off the roof. Such slope shall be in addition to designed camber to assure adequate drainage after long-time deflection from dead load.

EXCEPTION: Roofs may have less slope than required above when a rational structural analysis is performed by a structural engineer to assure stability and strength under ponding conditions and the stiffness of the structural members are at least that given by: $EI=225TL^3$ where T is the tributary area supported by the member in square feet and L is span length in feet.

Design rate of rainfall shall be a minimum of 6"/hr., based upon a 5 minute duration. Ponding loads need not be considered as occurring simultaneously with other live load.

Exhibit H (Page 2 of 2)

HASTAIN & DEATHERAGE, INC.
CONSULTING CIVIL AND STRUCTURAL ENGINEERS

LICENSED TO PRACTICE IN
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PHONE: (602) 957-0560 • 3801 EAST INDIAN SCHOOL ROAD • PHOENIX, ARIZONA 85018

JAMES H. DEATHERAGE, P.E.
FRED M. NELSON, P.E.

September 6, 1985

Mr. Brian O'Donnel, Chairman
MAG Building Code Committee
Building Official
City of Scottsdale
3939 Civic Center Plaza
Scottsdale, Arizona 85251

Subject: Roof Drainage Criteria
Per Uniform Plumbing Code

Dear Mr. O'Donnel:

During 1981-82 I was a member of the Roof Drainage Committee of the City of Phoenix Building Safety Department. The committee was organized in response to numerous roof failures resulting from excessive ponding.

Our committee determined that the 3"/hr. UPC rainfall criteria then required for roof design of City of Phoenix buildings was representative of a 1-2 year storm, because the UPC roof drainage tables were based upon a 5 min. intensity rainfall —— not the total 1 hr. rainfall. As a consequence, we revised the code to require a 6"/hr. intensity —— about a 15 year storm for the Phoenix area.

I urge your MAG committee to consider revising the roof drainage requirements throughout the valley. To assist you, I have included the City of Phoenix Roof Drainage criteria before and after our committee's work.

I would be happy to provide further assistance or answer any questions you may have.

Very truly yours,

HASTAIN & DEATHERAGE, INC.
Consulting Engineers

Fred M. Nelson

Fred M. Nelson, P.E.

FMN:pc
Enclosure