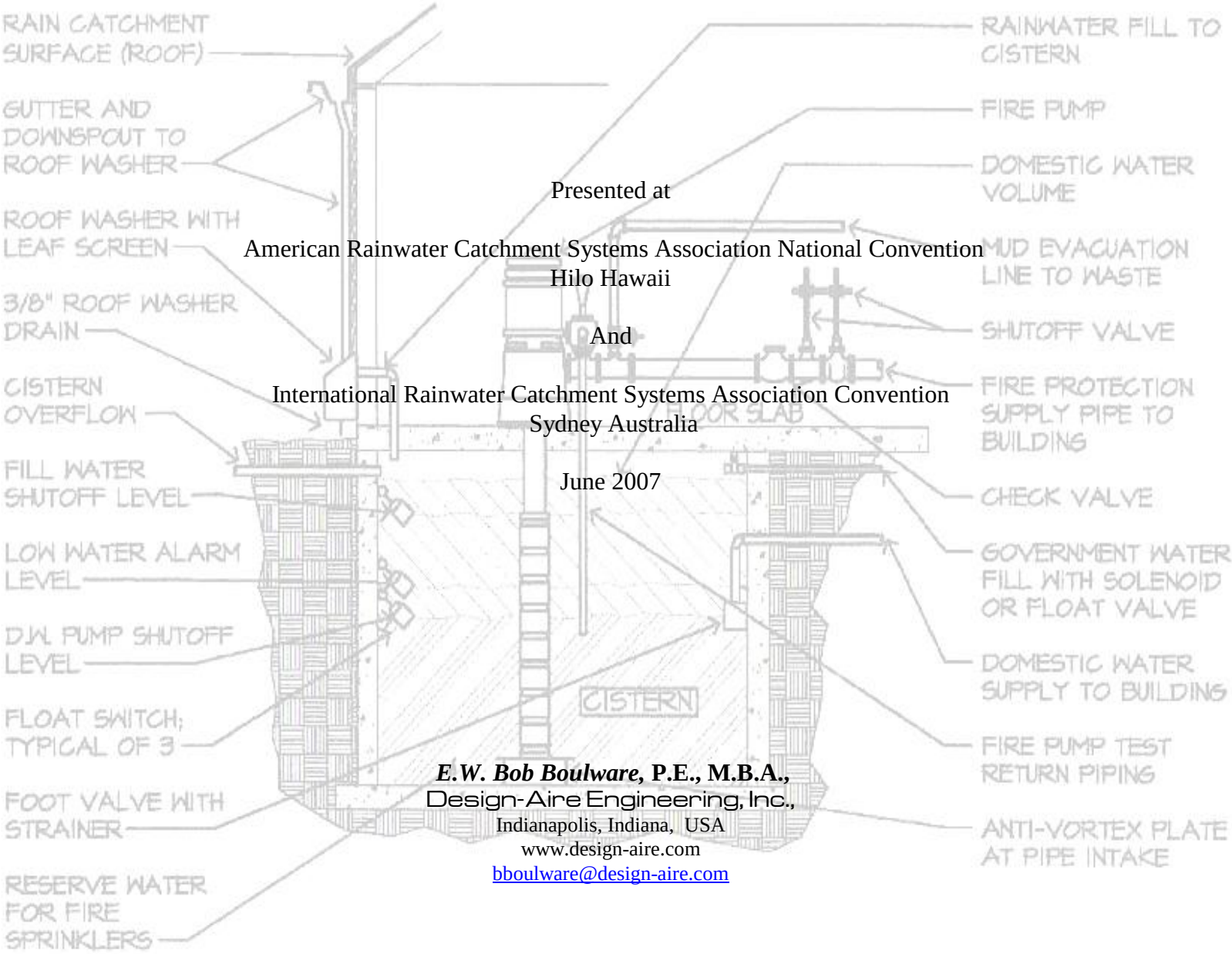
Integrating Automatic Fire Sprinkler Systems with Rainwater Catchment



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Abstract

Rainwater catchment is commonly thought of as applicable to remote buildings located on the fringes of civilization. Such is not the case for buildings located in the cities of the Virgin Islands, Bermuda, and elsewhere that water is limited. For these conditions, utilizing rainwater catchment as a water source for fire suppression sprinkler systems may provide a solution to the need.

In most cases, the requirements of fire suppression sprinkler system design are dictated by various Building Codes. Chiefly in the United States, the National Fire Protection Association 13 - Sprinkler Systems, commonly called NFPA 13, is the standard for design and code approval.

The water volume needed for fire protection depends on Occupancy, Design Area, Discharge Water Density, Flow Duration, type of sprinkler system (wet or dry type), and Hazard Classification, which is based on the type of construction and facility use. This volume is in addition to the water required for domestic use and is separated by having the domestic water suction only draw water out of the tank down to the level designated as the "Fire Reserve." Only the fire pump can draw water from the lowest part of the tank, which is then pumped into the sprinkler system.

Introduction

Rainwater catchment is commonly thought of as applicable to remote buildings located on the fringes of civilization. Such is not the case for buildings located in the cities of the Virgin Islands, Bermuda, and island locations in general. Here, historic buildings are often clustered together and fire protection is necessary to avoid major fires and disaster. Typical of these locations is a limitation of available water to fight a building fire. Utilizing rainwater catchment, to provide the water for fire suppression sprinkler systems to operate, may offer a solution to the need.

What are the standards of design?

In most cases, the requirements of fire suppression sprinkler system design are dictated by various Building Codes. Chiefly in the United States, the National Fire Protection Association 13 - Sprinkler Systems, commonly called NFPA 13, is the standard for design and code approval.
Design of sprinkler systems has three parts: determination of the water volume needed, the design of sprinkler distribution, and the design of the storage and pumping system necessary for sprinkler operation.[1] It is important to note that the final design will need the approval of the "authority having jurisdiction" before construction begins. This may be the local building inspector, fire chief, insurance underwriter, local or state code official, who may possibly modify the code requirements. So it is best to get his involvement early in the design process.

Table 4-1 Sprinkler System and Water Supply Design Requirements for Sprinklered Facilities

OCCUPANCY CLASSIFICATION[a]	SPRINKLER SYSTEM		HOSE STREAM ALLOWANCE L/Min (GPM)	DURATION OF SUPPLY Minutes
	DESIGN DENSITY L/min/m² (GPM/ft²)	DESIGN AREA m² (ft²) [b]		
Light Hazard	4.1 (0.10)	280 (3000)	950 (250)	60
Ordinary Hazard Group 1	6.1 (0.15)	280 (3000)	1900 (500)	60
Ordinary Hazard Group 2	8.2 (0.20)	280 (3000)	1900 (500)	90
Extra Hazard Group 1	12.2 (0.30)	280 (3000)	2840 (750)	120
Extra Hazard Group 2	16.3 (0.40)	280 (3000)	2840 (750)	120

[a] Refer to Appendix B for occupancy hazard classification.
[b] See paragraph 4-2.3.3.

Note: The protection requirements identified in Table 4-1 are based on standard commercial practices followed throughout civilian industry for highly protected risk (HPR) properties. Table 4-1 represents the minimum requirements necessary to establish minimum comprehensive life, mission, and property loss prevention. Table 4-1 was adapted as a result from detailed studies by Factory Mutual of loss experience from 1956 to 1965, loss experience in selected occupancies from 1966 to 1977 and from 1981-1990, and fire test data.

Figure 1: Sprinkler System Water Supply Requirements from United States Department of Defense Unified Facilities Criterion Document UFS 3-600-01.

[1]Determining the water volume is simplified by using the services of an engineer specializing in automatic fire suppression systems assist you in the design of the system. The final design will likely need his certification, so you might as well benefit from his assistance.

How Much Water Do We Need?

The water volume needed for fire protection depends on the Occupancy, the Design Area, Discharge Water Density, Flow Duration, type of sprinkler system (wet or dry type) and Hazard Classification based on type of construction and facility use.

For a Light Hazard occupancy[2], seen from information in Figure 1 taken from a typical code, would indicate that the needed water volume would be as follows:

The Design Area is 3,000 square feet (280 m^2). The design area used to calculate sprinkler water demand is independent of the actual building size and is based on the fact that typically no more than 10 sprinkler heads ever actually discharge when a fire occurs. It also corresponds to the most hydraulically remote part of the sprinkler system.

Design Density, which is .1 gallons per minute (gpm) / square foot (4.1 liter/m^2) in this example, is the volume of water needed to be delivered to the Design Area. This is determined by the Occupancy Classification as determined by the fuel value of the building contents. Added to the volume required for sprinkler operation is the water volume allowance needed for Fire Hose operation. In this case,250 gallons/minute (950 liters/minute).

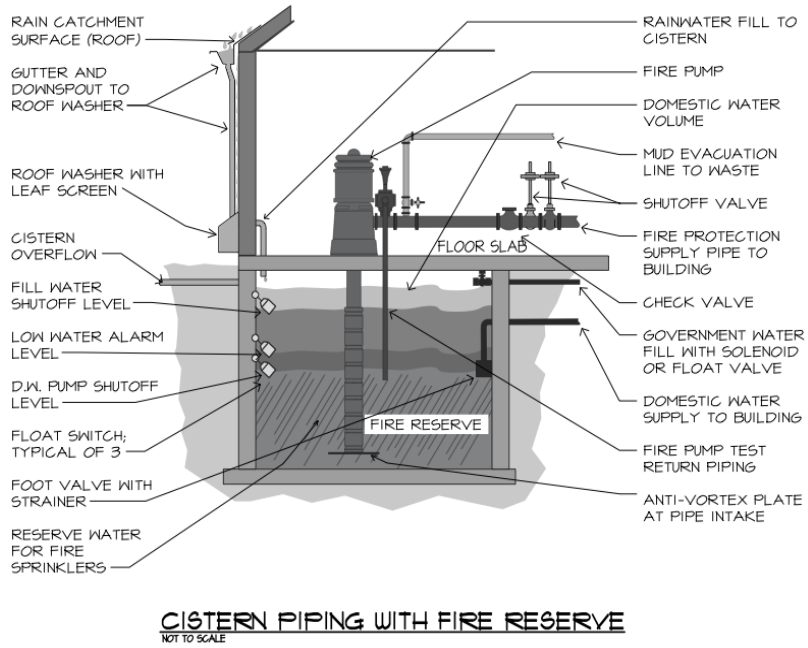

Figure 2: Cistern Piping with Fire Protection Reserve Allowance**.**

[2] Light Hazard construction would include dwellings such as apartments and hotels, and public buildings such as schools, churches and office buildings; with few combustibles and only small fires are expected. Ordinary hazard would include ordinary mercantile, manufacturing, and industrial installations where moderate amounts of combustibles are present and medium size fires considered. Extra hazard would include woodworking shops or high piled warehouses where the possibility of a severe fire exists.

Flow duration is 60 minutes, resulting in the minimally required water volume for automatic fire sprinkler system operation to be 33,000 gallons (125,880 liters)[3]. This volume is in addition to the water required for domestic use and is separated by having the domestic water suction only draw water out of the tank down to the level designated as the "Fire Reserve." Only the fire pump can draw water from the lowest part of the tank, which is then pumped into the sprinkler system by the fire booster pump. To accommodate regular fire pump testing, and avoid waste, provision for circulating the test water back into the cistern must be included in the design. Since pumps typically draw from the tank's lowest part, an additional discharge (e.g. to a sanitary sewer system) should be provided as a method for pumping the mud out of the tank. See Figure 2 for a typical cistern piping configuration with a fire reserve.

Fire Pump Selection

Once the necessary water volume is determined, from the point of the water supply to the fire pump, the system becomes a typical sprinkler design, best done by someone who specializes in this trade for approvals to go smoothly. The fire pump is a special pump, sized for the maximum flow volume (in the example, 550 gallons/minute (2,080 liters/minute))[4] but with variable flow controls to modulate pump flow proportional to the demand to avoid water hammer, and with enough pump head to maintain 20 psig at the top of the riser or end of the horizontal main, or 10 psig at the farthest sprinkler head.

Summary:

Harvesting rain for domestic water use is commonly used technology. Applying this same thinking for a fire sprinkler system is a simple extension of what is already known with only slight modifications. Chiefly this means adding a "sprinkler water reserve" to the domestic water volume, limiting how much water in your cistern is available for domestic water use to ensure sufficient water is available for fire protection; adding a means of recirculating water back into the cistern to prevent wasting the water during periodic pump testing is needed; and providing a discharge outside of the tank, to allow pumping the mud out. This latter modification will help maintain the water quality in the tank to eliminate the possibility of plugging the sprinkler heads during discharge. These minor modifications are typically all that are required for making a standard water storage system serve to protect your building.

[3] ((3,000 square feet * .1 gal/minute / square foot) + (250 gallons/minute)) * 60 minutes

[4] 33,000 gallons / 60 minutes