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APPENDIX A - SAMPLE CALCULATIONS

SAMPLE 1
INDUSTRIAL SITE

BUILDING 1

Description: 17,000 square feet, 4-story open loft parachute building, Type V (combustible) construction, automatic sprinkler system installed (see fig A-1).

Procedure:

- Step 1 item 1 Type V (combustible) construction
- item 2 Multiple story building
- item 3 Ordinary hazard (Group 3) occupancies
- item 4 17,000 square feet per floor (from plans)
- item 5 Building 1 to 3 - 30 feet
Building 1 to 2 - 70 feet (from area plan)
- item 6 Automatic sprinkler system (wet system) installed

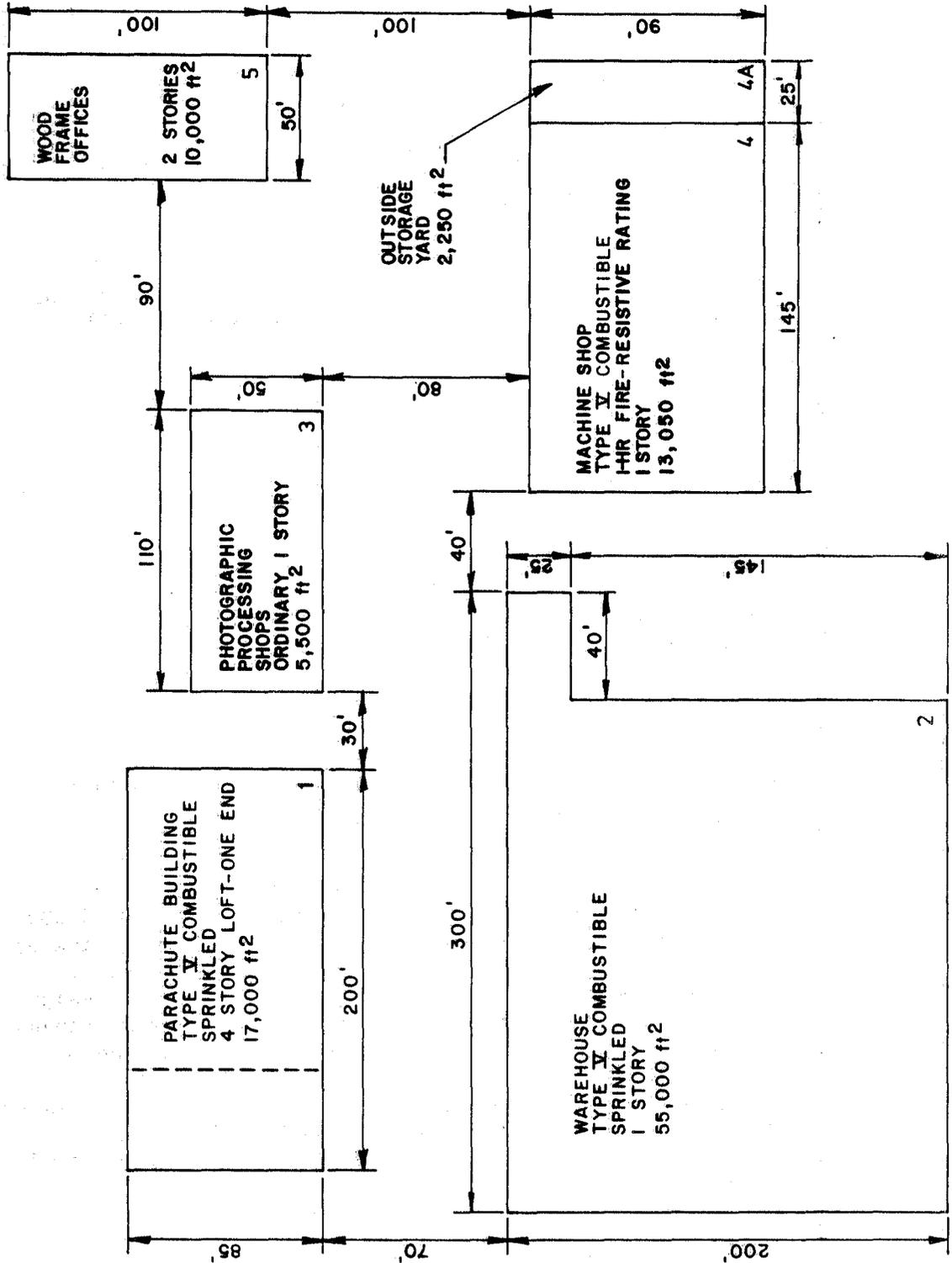
Move to step 8 as automatic sprinkler system is installed.

- Step 8 For this example, the building sprinkler system is designed to deliver 0.25 gpm per square feet over 3,000 square feet (see table 3-3) and the calculated sprinkler system demand is 825 gpm at 70 psi residual pressure (actual demand is obtained from sprinkler system design calculations). To this, the required hose stream demand of 500 gpm (table 3-3) must be added to obtain the required fire flow demand of 1,500 gpm (825 + 500, rounded to 1,500). The required fire flow duration is 90 minutes (table 3-3). The sprinkler system design is obtained from NFPA recommendations (except water demand criteria).

BUILDING 2

Description: 55,000 square feet, one-story warehouse, Type V (combustible) construction.

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FIGURE A-1. SAMPLE 1 AREA PLAN

Procedure:

- Step 1 item 1 Type V (combustible) construction
- item 2 1 story - single story building
- item 3 Extra hazard occupancies
- item 4 55,000 square feet per floor
- item 5 Building 2 to 1 - 70 feet
Building 2 to 3 - 70 feet
Building 2 to 4 - 40 feet
(Use only the closest distance between the buildings for the distance.)
- item 6 Automatic sprinkler system (Dry System).

Move to step 8 as automatic sprinkler system is installed.

- Step 8 For this example, the building sprinkler system is designed to deliver 0.35 gpm per square foot over 3,900 square feet (3,000 square feet plus 30 percent increase in design area for dry pipe system) resulting in a calculated sprinkler system demand of 1,500 gpm at 70 psi residual pressure (calculated demand includes a 10 percent increase in flow to account for differential flows at far ends of system). To this, the required hose stream demand of 750 gpm must be added to obtain the required fire flow demand of 2,250 gpm. The required fire flow duration is 105 minutes.

BUILDING 3

Description: One-story, 5,500 square feet, photographic processing area, ordinary construction.

Procedure:

- Step 1 item 1 Type V (combustible) construction
- item 2 1 story - single story
- item 3 Light hazard occupancies
- item 4 5,500 square feet per floor
- item 5 Building 3 to 1 - 30 feet

Building 3 to 2 - 70 feet

Building 3 to 4 - 80 feet

Building 3 to 5 - 90 feet

item 6 No automatic sprinklers, no special systems.

Step 2 Refer to figure 3-1 or 3-2 for Type V construction, curve 1 for light hazard occupancies, 1 story.

Step 3 Read the basic fire flow from the curve based on an area of 5,500 square feet, 1,140 gpm.

Step 4 item 1 Building 3 to 1 - Separation factor of 3

Building 3 to 2 - Separation factor of 2

Building 3 to 4 - Separation factor of 2

Building 3 to 5 - Separation factor of 2

item 2 Total separation factor = $3 + 2 + 2 + 2 = 9$

item 3 Exposure factor from figure 3-3 is 1.48.

item 4 Required fire flow = $1,140 \times 1.48 = 1,687$ rounded to 1,750.

Step 5 The duration is 3 hours from table 3-2.

Step 6 A fire department pumper will be used. The fire flow test shows the required flow is available at a residual pressure of 20 psi, so the required residual pressure is 20 psi.

Step 7 No special systems are installed.

Step 8 No sprinkler systems provided.

BUILDING 4

Description: Machine shop, 13,050 square feet, Type V (combustible) construction, 1 story, with an outside storage yard to the east. (Note: the storage yard is considered separately.)

Procedure:

Step 1 item 1 Type V (combustible) construction

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item 2 1 story - single story building

item 3 Ordinary hazard occupancies

item 4 13,050 square feet per floor

item 5 Building 4 to 2 - 40 feet

Building 4 to 3 - 80 feet

Building 4 to 5 - 100 feet

Building 4 to Yard 4A - 0 feet

The storage yard is handled as a building for development of exposure increases.

item 6 No automatic sprinklers or special systems installed.

Step 2 Refer to figure 3-1 or 3-2 for Type V (combustible) construction, curve 3 for ordinary hazard occupancies, single story.

Step 3 Read the basic fire flow from the curve based on the area of 13,050, 1,620 gpm.

Step 4 item 1 Building 4 to 2 - Separation factor of 3

Building 4 to 3 - Separation factor of 2

Building 4 to 5 - Separation factor of 2

Building 4 to 4A - Separation factor of 5

item 2 Total separation factor = $3 + 2 + 2 + 5 = 12$

item 3 Exposure factor from figure 3-3 is 1.63

item 4 Required fire flow = $1,620 \times 1.63 = 2,640$ rounded to 2,750

Step 5 The duration is 3 hours from table 3-2.

Step 6 The water is supplied from existing mains at the site. A fire flow test has shown there are 2,750 gpm at 22 psi residual available at the site. Since this is greater than 20 psi, a pumper will be used and no upgrade of the existing system is required.

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Step 7 No special systems are installed.

Step 8 No sprinkler systems provided.

YARD STORAGE

Description: 8 feet high yard storage, metal parts in wood crates, with 2,250 square feet available for storage.

Procedure:

Step 1 item 1 The storage is not over 15 feet high and is classified as low piled storage.

item 2 The storage is classified as combustible because of the wood crates.

item 3 2,250 square feet is available.

item 4 Yard 4A to Building 4 - 0 feet

Yard 4A to Building 5 - 100 feet

Step 2 Refer to figure 4-1 or 4-2 curve 2 for low piled combustible storage.

Step 3 The basic fire flow from curve 2 based on the area of 2,250 square feet is 650 gpm.

Step 4 item 1 Yard 4A to Building 4 - Separation factor of 5

Yard 4A to Building 5 - Separation factor of 2

item 2 Total separation factor - 7

item 3 Exposure factor from figure 3-3 is 1.375.

item 4 Required fire flow = $650 \times 1.375 = 894$ rounded to 1,000 gpm.

Step 5 The duration is 2 hours from table 3-2.

Step 6 Since this facility is adjacent to Building 4, it is obvious by inspection that the existing system is adequate with use of a pumper.

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BUILDING 5

Description: 2-story, Type V (combustible) construction, wood frame office building, 10,000 square feet total area (5,000 each floor)

Procedure:

- Step 1 item 1 Type V (combustible) construction
- item 2 2 story - multistory building
- item 3 Light hazard occupancies
- item 4 5,000 square feet per floor
- item 5 Building 5 to 3 - 90 feet
Building 5 to 4 - 100 feet
Building 5 to Yard 4A - 100 feet
- item 6 No automatic sprinklers or special system installed.
- Step 2 Refer to figure 3-1 or 3-2 Type V (combustible) construction, curve 2 for multistory light hazard occupancies.
- Step 3 The basic fire flow from the curve based on an area of 5,000 square feet per floor is 1,280 gpm.
- Step 4 item 1 Building 5 to 3 - Separation factor of 2
Building 5 to 4 - Separation factor of 2
Building 5 to Yard 4A - Separation factor of 2
- item 2 Total separation factor = $2 + 2 + 2 = 6$
- item 3 Exposure factor from figure 3-3 is 1.325
- item 4 Required fire flow = $1,280 \times 1.325 = 1,696$, rounded to 1,750 gpm
- Step 5 The duration of the required fire flow is 3 hours from table 3-2.

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Step 6 A fire flow test from existing hydrants nearest the site shows a flow available of 1,750 gpm at a residual pressure of 25 psi. With use of a pumper, the existing system is adequate.

Step 7 No special systems are installed.

Step 8 No automatic sprinkler systems provided.

SUMMARY

Based on the required fire flow demands for the six subject facilities on this area, the water supply system needs to provide 2,750 gpm at 20 psi for 3 hours (based on Building 4, the building with the highest demand). The system also needs to provide 2,250 gpm at 70 psi to supply the sprinkler system in Building 2 or a fire pump is needed for Building 2. If 1,500 gpm at 70 psi is not available at Building 1 for its sprinkler system, a fire pump will be required. These requirements are in addition to domestic or process water demands.

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SAMPLE 2
POL FACILITY

Description: Flammable liquids storage in above-ground atmospheric tanks, pressurized LP gas storage in above-ground pressurized tanks, and pumping facilities (see fig A-2).

1. Above-ground atmospheric POL tanks

Step 1 Cooling water, 500 gpm for Tank 1 from table 4-1.

Step 2 Provide additional cooling water, as required by paragraph 4-2.b., for:

Tank 2 - 500 gpm

Pressure Vessel 5 - 500 gpm

Pump House 3 - 500 gpm

Step 3 No special systems are installed.

Step 4 Total required fire flow rate
= 500 + 500 + 500 + 500 = 2,000 gpm.

Step 5 Duration 4 hours, as required by paragraph 4-2.e.

Step 6 The minimum residual pressure is to be 20 psi with use of a pumper or other pressure boosting measures.

2. Above-ground pressurized tanks

Step 1 Cooling water, 500 gpm from table 4-2.

Step 2 Provide additional cooling water, as required by paragraph 4-3.b., for:

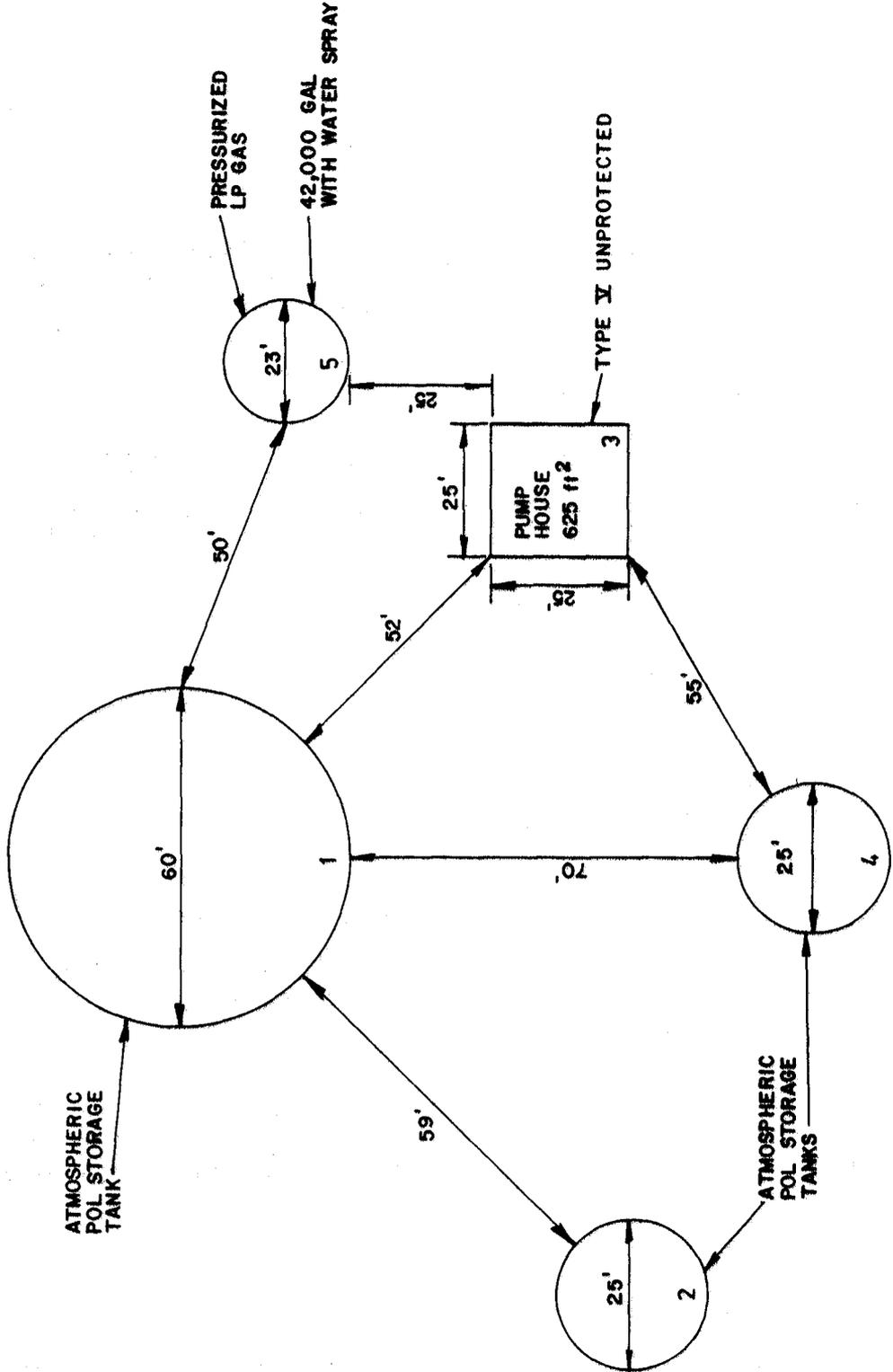
Tank 1 - 500 gpm

Pump House 3 - 250 gpm

Step 3 A water spray system meeting the following requirements, as required by NFPA 30:

Surface area = 1,662 square feet x .25 gpm/square feet = 415 gpm, 80 psi minimum pressure, from actual hydraulic calculation of water spray system.

Step 4 Required fire flow rate = 500 + 500 + 250 + 415 = 1,665, rounded to 1,750 gpm.



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FIGURE A-2. SAMPLE 2 AREA PLAN

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Step 5 Duration of 4 hours as required by paragraph 4-3.e.

Step 6 The minimum residual pressure is to be 20 psi with use of a pumper or other pressure boosting measures.

3. Pump House

Step 1 item 1 Type V (1-HR fire-resistive rating) construction

item 2 1 story - single story

item 3 Extra hazard occupancies

item 4 625 square feet

item 5 Pump house to LP gas tank - 25 feet

Pump house to 60 foot tank - 52 feet

Pump house to 25 foot tank - 55 feet

item 6 No special protection provided

Step 2 Refer to figure 3-1 or 3-2 for Type V (combustible) construction, curve 5 for 1 story, extra hazard occupancies.

Step 3 The basic fire flow, using the area of 625 square feet, is 1,600 gpm.

Step 4 item 1 Pump house - LP tank - separation factor of 4

Pump house - 60 foot tank - Separation factor of 2

Pump house - 25 foot tank - Separation factor of 2

item 2 Total separation factor = $4 + 2 + 2 = 8$

item 3 Exposure factor from figure 3-3 = 1.425

item 4 Required fire flow rate = $1,600 \text{ gpm} \times 1.425 = 2,280 \text{ gpm}$, rounded to 2,300 gpm

Step 5 Duration of flow is 4 hours.

Step 6 The minimum residual pressure is to be 20 psi with use of a pumper or other pressure boosting measures.

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Step 7 No special systems are installed.

Step 8 No sprinkler systems provided.

SUMMARY

This POL facility has a required fire flow demand of 2,300 gpm. A minimum residual pressure of 20 psi will be obtained with or use of a pumper or other pressure boosting measures.

SAMPLE 3
EXPLOSIVES OPERATING BUILDING

Description: 15,000 square feet, 2-story ordnance plants, Type V construction, automatic deluge sprinkler system installed in exposed powder area (3,000 square feet) and wet pipe automatic sprinkler system installed in balance of building. Exposed powder area is separated from balance of building by fire walls.

Procedure:

- Step 1 item 1 Type V (combustible) construction
- item 2 2 stories - multiple-story building
- item 3 Ordinary hazard occupancies (Group 3) - without exposed powder area
- item 4 7,500 square feet per floor
- item 5 No exposed facilities within 150 feet
- item 6 Automatic sprinkler systems installed

Move to step 8 as automatic sprinkler systems are installed

Step 8 For this example, the building sprinkler system is designed to deliver 0.25 gpm per square foot over 3,000 square feet except in exposed powder areas where 0.50 gpm per square foot is provided over the entire exposed powder area. The calculated wet pipe sprinkler system demand is 1,100 gpm at 75 psi residual pressure and the deluge sprinkler system demand is 1,800 gpm at 115 psi (actual demand is obtained from sprinkler system design calculations). Because the exposed powder area is separated from the balance of the building by fire walls, only the highest demand (1,800 gpm at 115 psi) needs to be provided. If the fire walls were not provided, both demands would need to be supplied simultaneously. To this demand, the hose stream demand of 750 gpm must be added to obtain the required fire flow demand of 2,500 gpm at 115 psi (1,800 + 750, rounded to 2,500). The required fire flow duration is 45 minutes. The sprinkler system design is obtained from NFPA recommendations (except water demand criteria).