CBSpk

Congresso Brasileiro de Sprinklers

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ABSpk Associação Brasileira de Sprinklers

Fire Pump Layout and Sizing

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Learning Outcomes

- Identify the appropriate sections of NFPA 20 that apply to sizing and layout of fire pumps.
- Identify the components of a fire pump and driver.
- Describe the purpose of the various components of a fire pump and driver.
- Describe the steps necessary for appropriately sizing a fire pump.
- Discuss the variables that impact the layout of a fire pump and how they are addressed.

Outline

- Review of Fire Pump Basics
- Selecting a Fire Pump and Enclosure
- Fire Pump Layout

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NFPA 20

- Administration
- Referenced Publications
- Definitions
- General Requirements
- Centrifugal Pumps
- Vertical Shaft Turbine Pumps
- Positive Displacement Pumps

NFPA 20

- Electric Drive for Pumps
- Electric Drive Controllers and Accessories
- Diesel Engine Drive
- Engine Drive Controllers
- Steam Turbine Drive
- Acceptance Testing

Related Standards

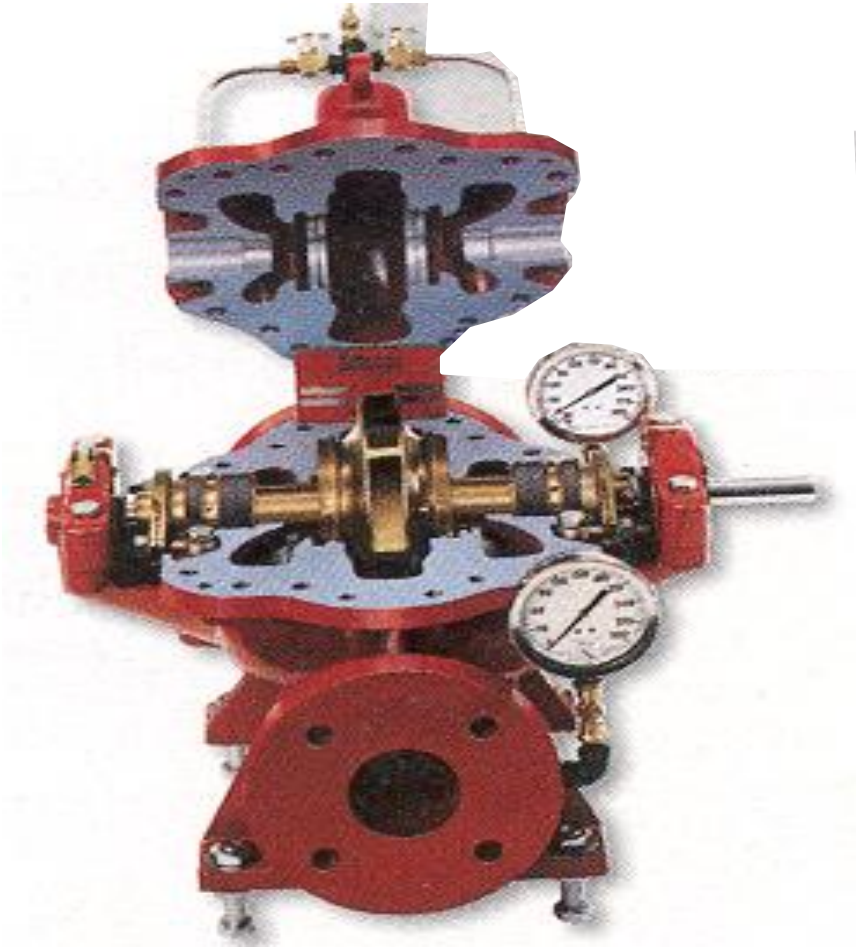
- NFPA 22, Water Tanks for Private Fire Protection
- NFPA 24, Private Fire Service Mains and their Appurtenances
- NFPA 25, Inspection, Testing and Maintenance of Water-Based Fire Protection Systems
- NFPA 70, National Electric Code
- NFPA 110, Emergency & Standby Power Systems

Review of Fire Pump Basics

- Types of Fire Pumps
- Pressure Maintenance Pumps (Jockey Pumps)
- Types of Drivers
- Fire Pump Enclosures
- Fire Pump Controllers
- Pressure Sensing Issues
- Low Suction Issues

Fire Pumps

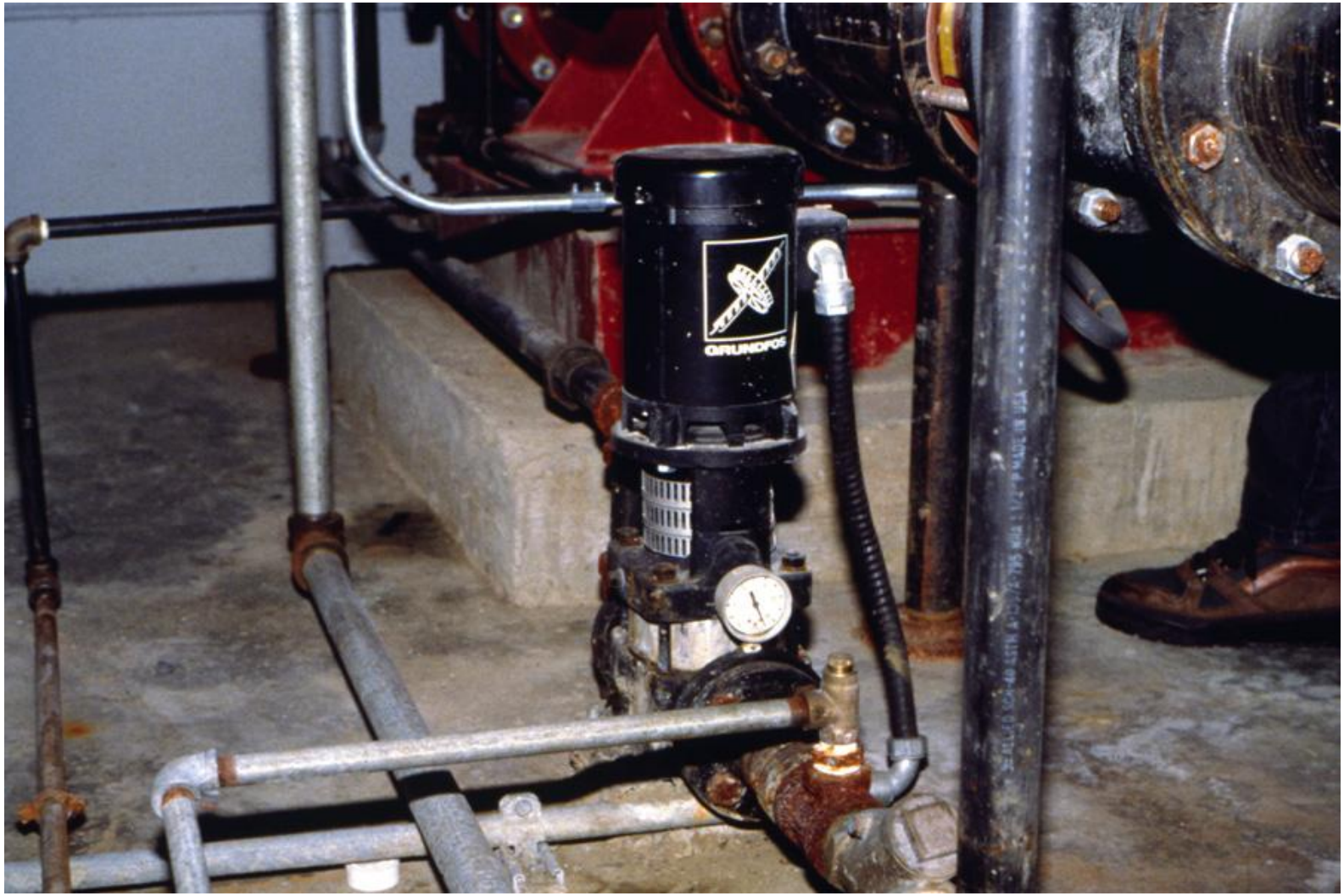
Horizontal Split Case Fire Pump



In-Line Pump

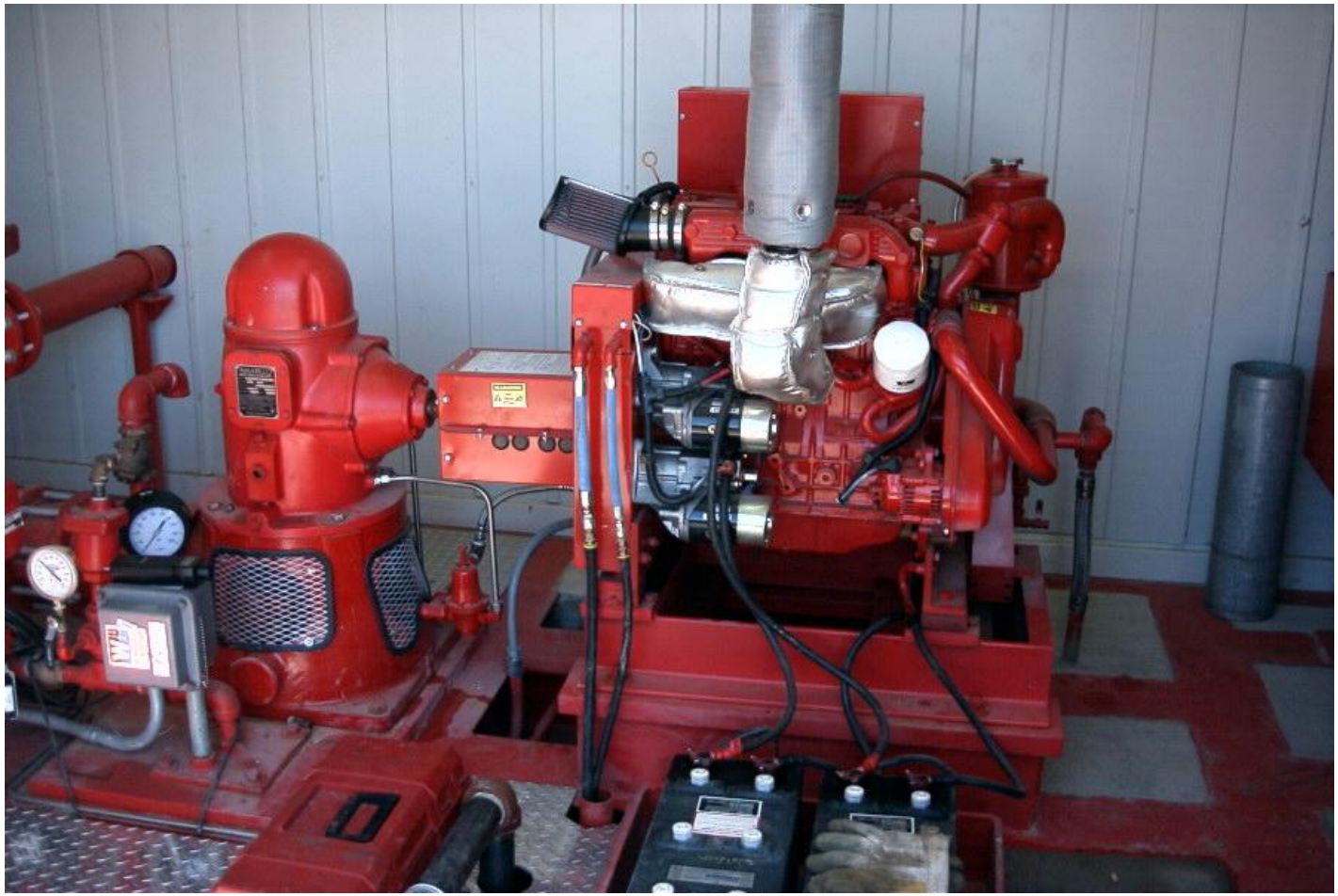
Vertical Shaft Turbine Pump

Jockey Pump



Electric Motor Driver

Diesel Engine Driver



Fire Pump Enclosure

Fire Pump Enclosure

- Access (Testing / Service / Repair)
- Piping (10X Rule)
- By-Pass
- Backflow Devices / Strainers / Check Valves / Suction Control Devices / Control Valves
- Pump and Driver
- Controller / Transfer Switch / Pressure Sensing Lines

Fire Pump Enclosure

- Wiring / Main Electrical Service
- Fuel Tanks (Diesel)
- Jockey Pump
- Relief Devices / Drains
- Heaters or Ventilation
- Test Header Piping
- Closed Loop Metering

Fire Pump Location & Protection

- Purpose is two fold:
- Fire Pump must be protected from interruption of service.

Fire Pump Protection

- NFPA 20 - Section 4.12.1 requires protection from:
- Explosion and fire
- Flood and earthquake
- Rodents and insects
- Windstorm and freezing
- Vandalism
- Other adverse conditions

Fire Pump Protection

- Purpose is two fold:
- Personnel at fire pump must be protected.
-

Fire Pump Protection

- Section 4.3.1 states:
- In the event of fire pump operation, qualified personnel shall respond to the fire pump location to determine that the fire pump is operating in a satisfactory manner.
-

Fire Pump Location

- NFPA 20 requires the location of and access to the fire pump room be pre-planned with the fire department.

Fire Pump Location

- NFPA 20 does not require fire pump to be located indoors or give specifics for acceptable locations.
- NFPA 20 provides a performance-based specification that must be met.

Fire Pump Location

- Most fire pumps are located indoors in Pump Houses or Pump Rooms in order to comply with these requirements.

Fire Pump Location

- Fire Pump Located Outdoors:
- Must Still Comply with Section 4.12.1
- Must be 50ft away from building
- Annex recommends at least a roof or deck to protect from rain and the sun

Fire Pump Outdoors

Fire Pump Location

- Fire Pump Located Outdoors:
- Must till Comply with Section 4.12.1
- Must be 50ft away from building
- Annex recommends at least a roof or deck to protect from rain and the sun

Separation:

- During a fire, a person is at the pump to monitor for proper operation. This person needs to be protected. This is accomplished by:
- Separating the pump house from the building.
- Fire Resistive Construction.

Separation:

- Pump House:
- Must be 50 ft away from building
- Pump Room:
- 2 hr fire-rated – Building not sprinklered or high-rise
- 1 hr fire-rated – Building sprinklered (not including high-rise buildings)

Separation:

TABLE 4.12.1.1.2 Equipment Protection

Pump Room/House	*Building(s) Exposing Pump Room/House*	*Required Separation*
Not sprinklered	Not sprinklered	2 hour fire-rated
Not sprinklered	Fully sprinklered	or
Fully sprinklered	Not sprinklered	50 ft (15.3 m)
Fully sprinklered	Fully sprinklered	1 hour fire-rated
		or
		50 ft (15.3 m)

Separation:

The “Not Sprinklered” column is to provide guidance for unsprinklered buildings:

Sprinklers are required in pump rooms in fully sprinklered buildings per NFPA 13

Pump Houses

Pump Houses

- 50 ft away from structure
- Pump Houses are generally constructed of non-combustible materials so that they are not threatened by nearby fire.
- Pump house with combustible roof is acceptable if sprinklered.

Pump Rooms

Pump Rooms

- Must be dedicated to fire pump and associated equipment.
- No Storage allowed
- Domestic Water Distribution equipment allowed.

Pump Rooms

- Must be separated from the rest of the building
  - 2 hour separation – non sprinklered buildings
  - 2 hour separation – High-rise buildings
  - 1 hour separation – fully sprinklered buildings (non high-rise).

Pump Rooms

- Should have direct access to outside. When this is not possible:
- Access through an enclosed passageway to an enclosed stairwell or exit.
- Passageway must have fire resistance rating at least equal to fire pump room.

Size of Pump House/Room

- Pump House/Room shall be sized to fit all necessary equipment and accommodate:
- Clearance for installation and maintenance
- Clearance for Electrical equipment
- Orientation of pump to suction piping

Clearances (IBC)

- Fire pump and automatic sprinkler system riser rooms shall be designed with adequate space for all equipment necessary for the installation, as defined by the manufacturer, with sufficient working room around the stationary equipment.

Clearances (IBC)

- Clearances around equipment to elements of permanent construction, including other installed equipment and appliances, shall be sufficient to allow inspection, service, repair or replacement

Clearances (IBC)

- Fire pump rooms shall be provided with a door(s) and unobstructed passageway large enough to allow removal of the largest piece of equipment

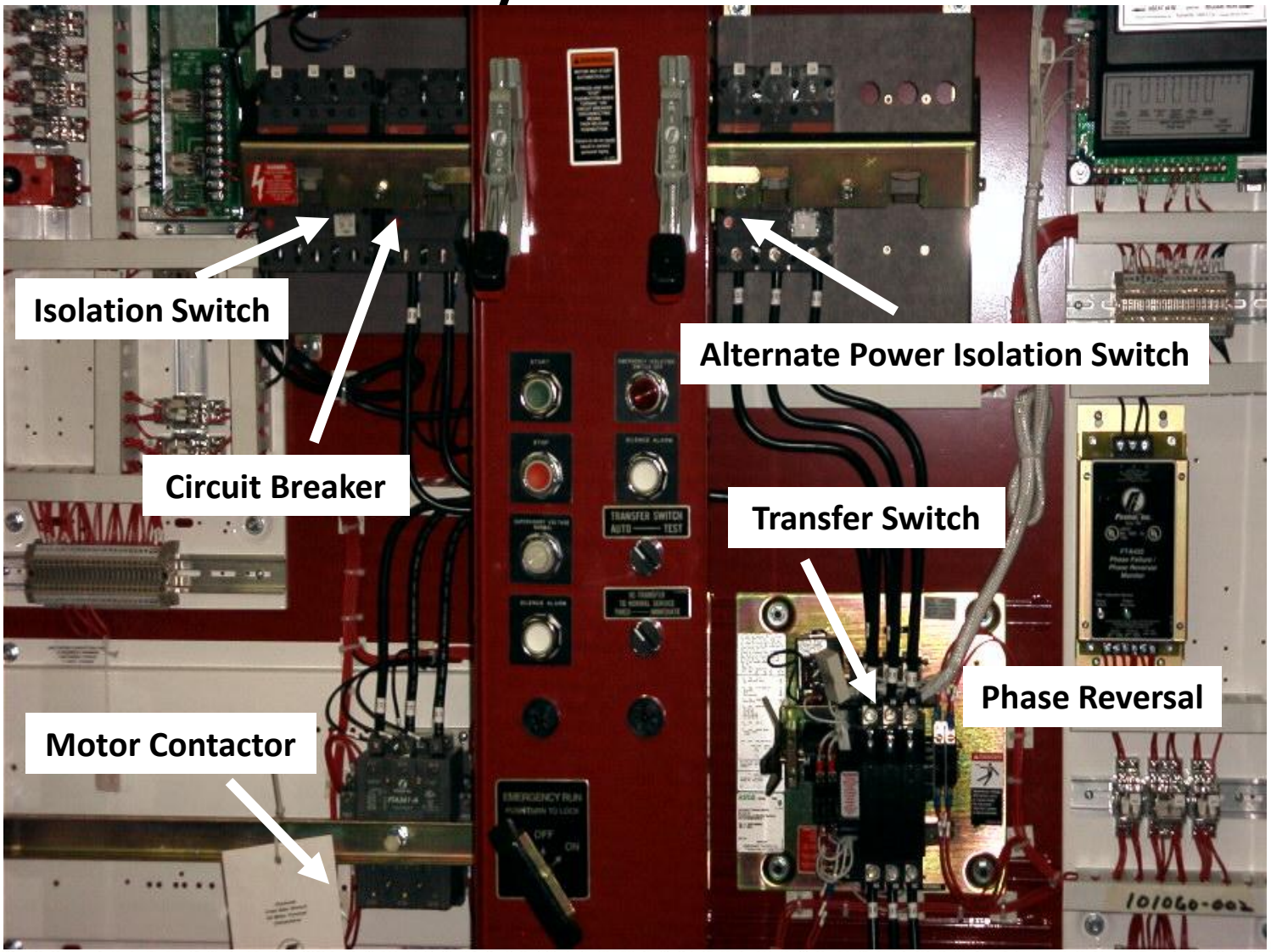
Clearances

- Working clearances around controllers shall comply with NFPA 70, National Electrical Code, Article 110

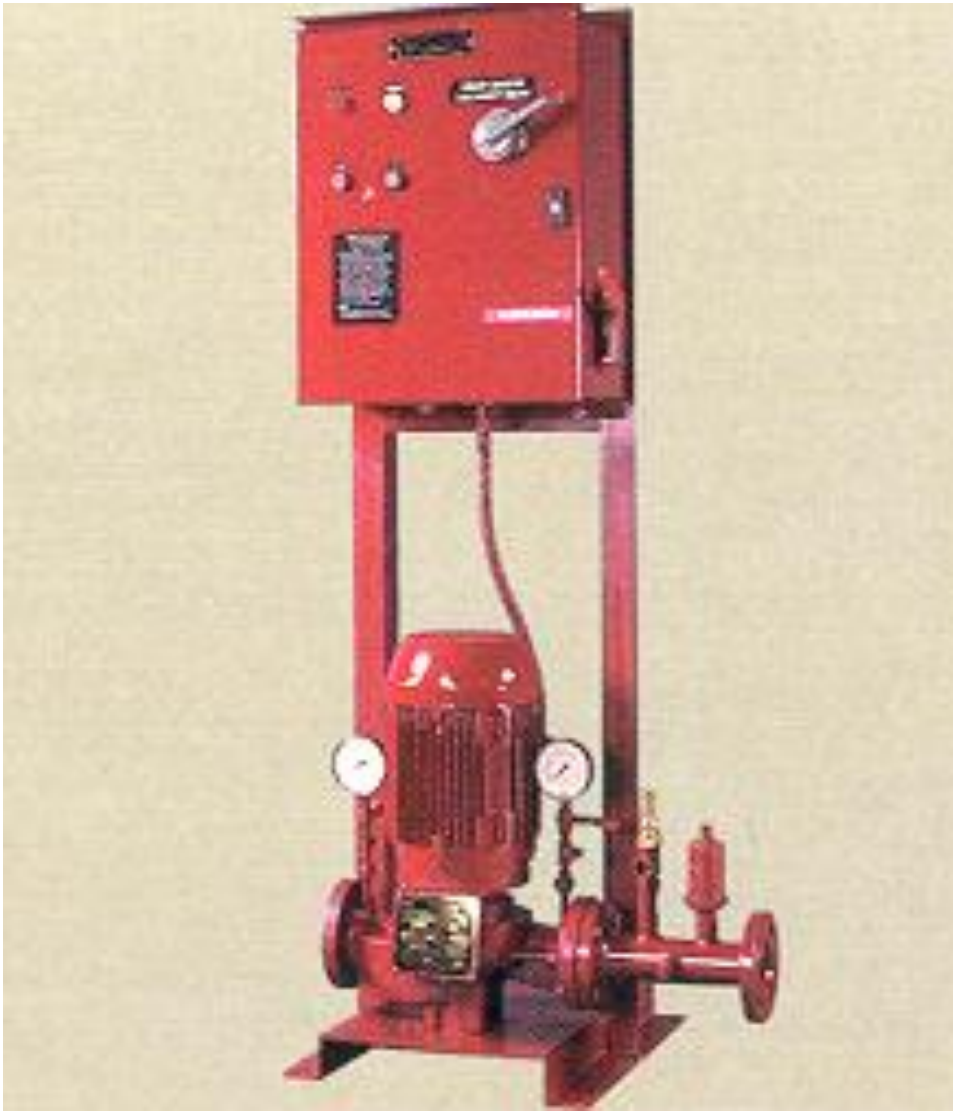
Equipment Access

Controller / Transfer Switch

Controller / Transfer Switch



Limited Service Controller



Equipment Protection

Pump Room/House	Buildings Exposing Pump Room/House	Required Separation
Not Sprinklered Not Sprinklered Fully Sprinklered	Not Sprinklered Fully Sprinklered Not Sprinklered	2 Hour Fire-Rated Or 15.3m (50 ft)
Fully Sprinklered	Fully Sprinklered	1 Hour Fire-Rated Or 15.3m (50 ft)

Note: Special Requirements for High-rise 4.12.1.1.2 (10)

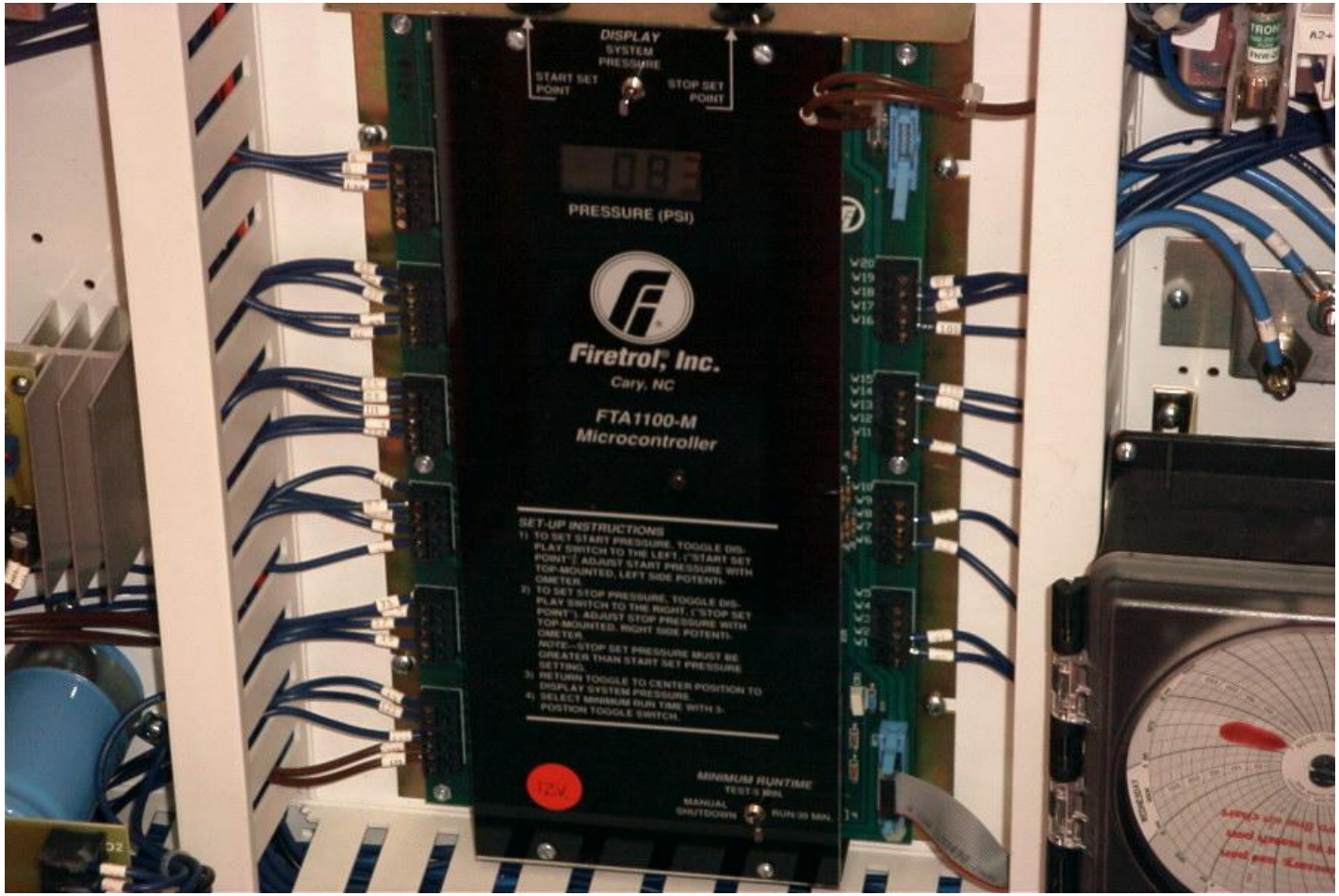
Pressure Sensing Issues

- Setting Jockey & Main Fire Pump Start Pressures
- Anywhere from 5 psi to 10 psi over main fire pump start point (Jockey should start first)
- Jockey pump sized so that GPM rating does not exceed flow from single sprinkler
- Insurance carrier will usually specify pressure they want jockey pump set at.

Section 4.25 Pressure Maintenance Pumps

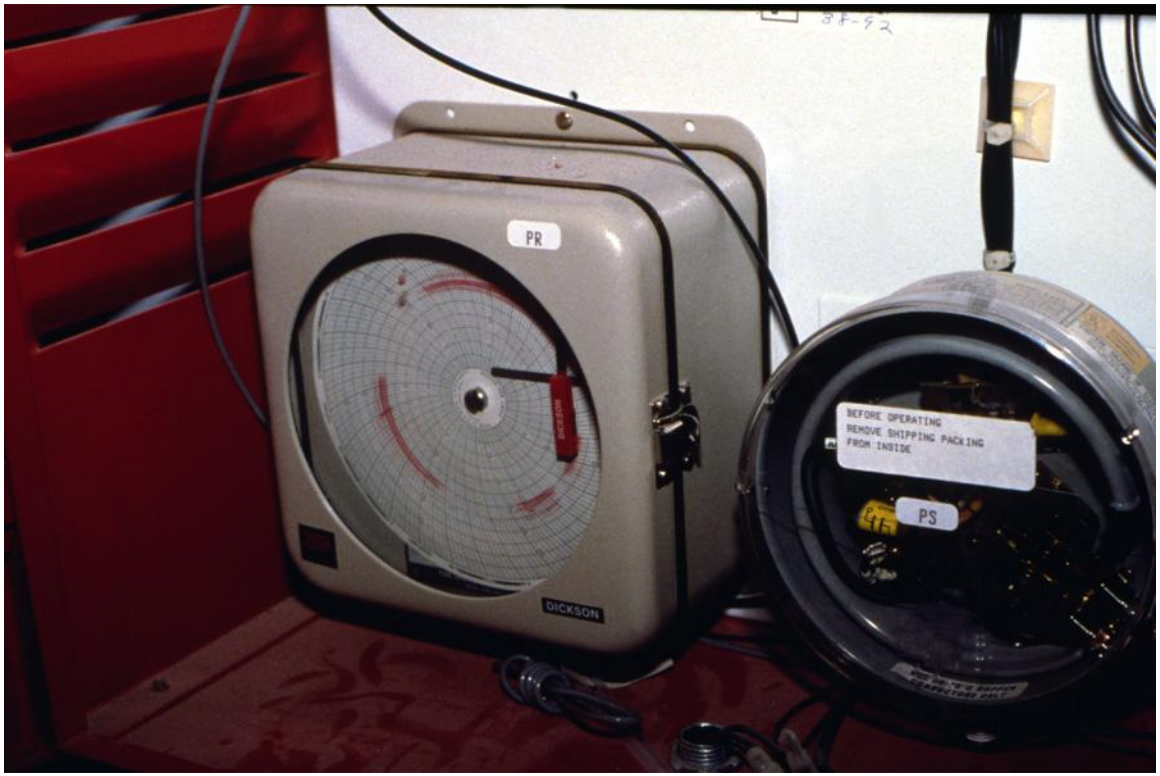
Pressure Sensing Issues

Electronic Pressure Monitor



Transducer Pressure Switch

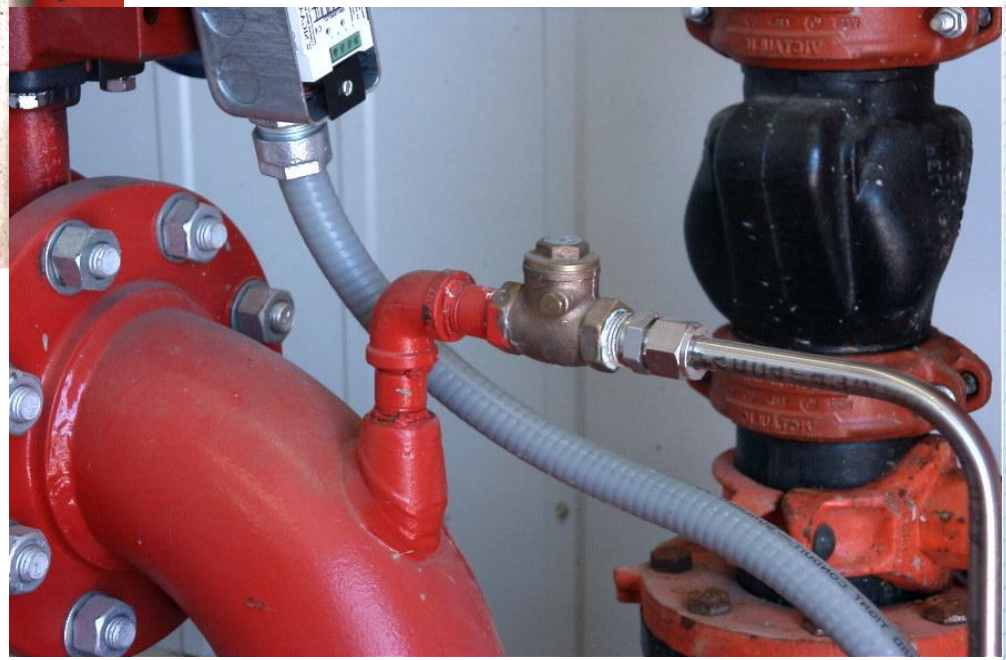
Pressure Recorder



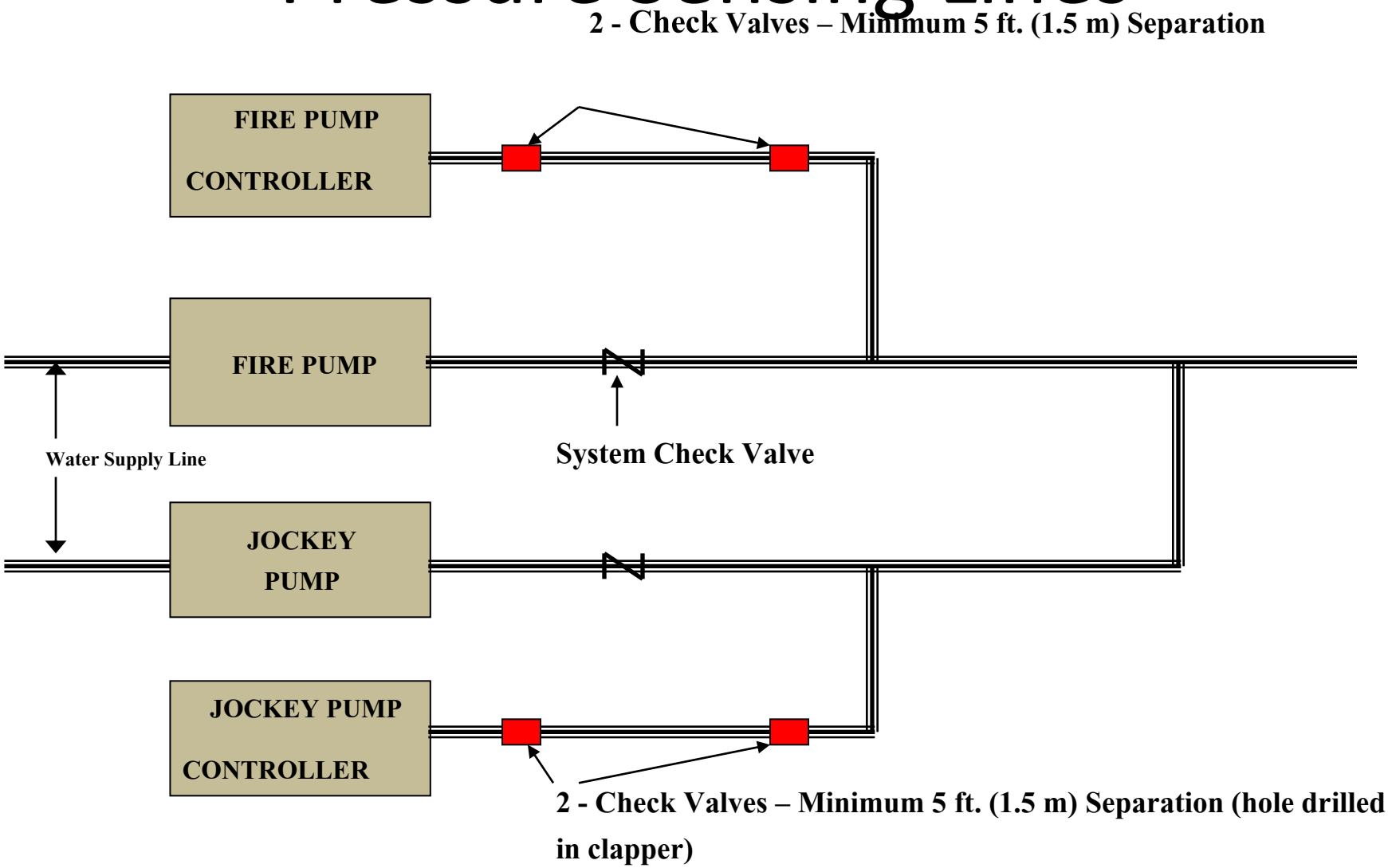
Pressure Sensing Lines

Check Valve At Controller

Check Valve At System Piping



Pressure Sensing Lines



Pressure Relief Devices

- NFPA 20 Standard does not want these devices used unless absolutely necessary (diesel fire pumps) due to potential failure of device which could impair fire protection water supply

Pressure Relief Valve

Selecting A Fire Pump & Enclosure

- What Type Fire Pump?
- What Size? (GPM/PSI)
- What Type Fire Pump Driver?
  - Emergency Power?
- What Type of Enclosure? (Size)

Selecting A Fire Pump & Enclosure

- Test Header Location – Flow Testing
- Earthquake Protection?
- Specifications/Insurance Requirements?
- Last but not least – Cost?
- Resource Assistance
  - Manufactures Representative

Fire Pump Size & Water Supply

- Fire Protection Demand (GPM / PSI)
  - Fire Protection System Demand
  - Water Supply Adjustments (Water Purveyor – AHJ)
    - Seasonal / 5%, 5 psi, 10%, 10 psi, AHJ
      - Limit water flow per main size (GPM)
    - Water Rationing
    - Environmental Consideration

Section 4.6 (03) (07) (10) Liquid Supplies

Fire Pump Size & Water Supply

- Water Supply
  - Quality of Water Supply (Ponds, Rivers)
  - Local Water Purveyor
  - Raw Water Supply – On-Site
  - (Tanks, Ponds, Rivers)

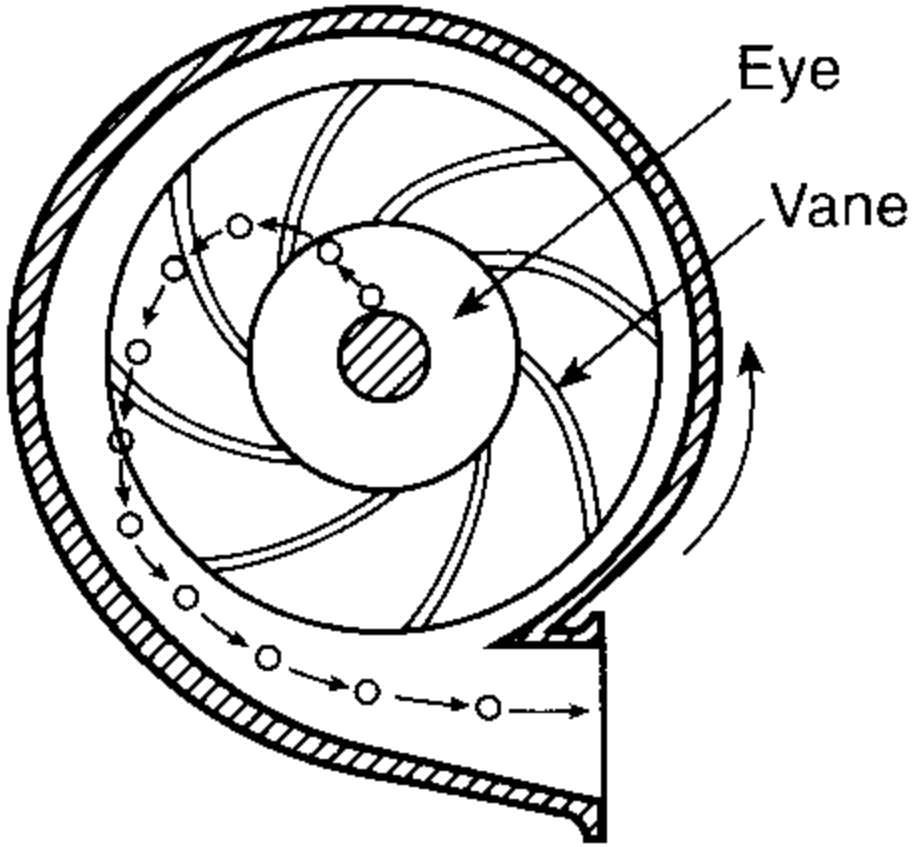
Fire Pump Sizing - Impact

- Performance
- Reliability
- Economics

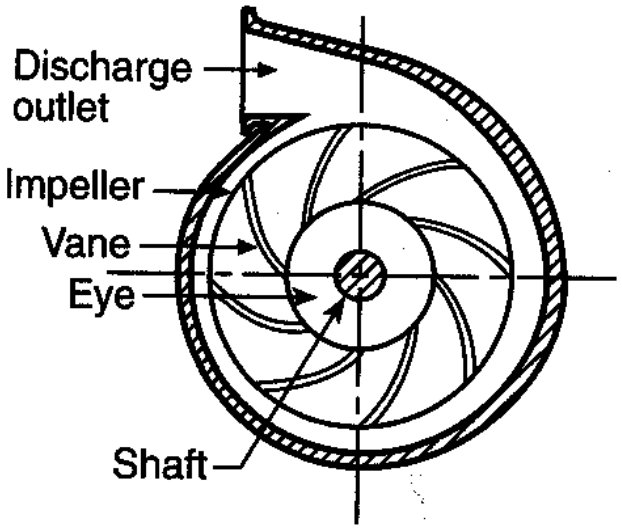
NFPA 20 Fire Pump Criteria

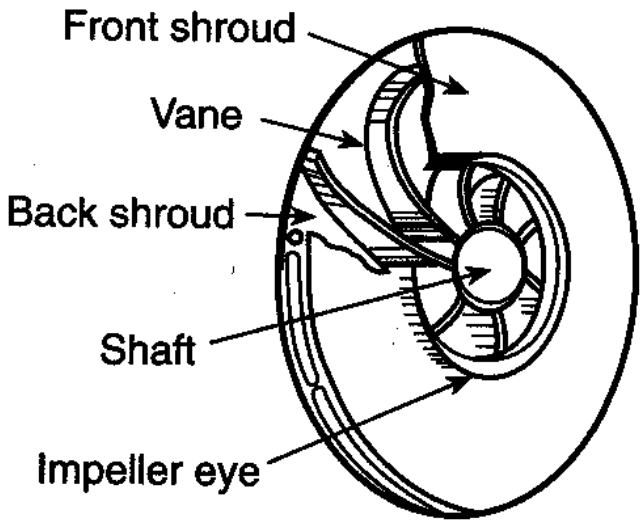
- Pumps shall furnish 150% capacity at not less than 65% of total rated head
- Shutoff head shall not exceed 140% of rated head
- Gage Pressure suction at suction flange shall be 0 psi or higher
    - Exception for suction tanks may drop to -3 psi

Centrifugal Force

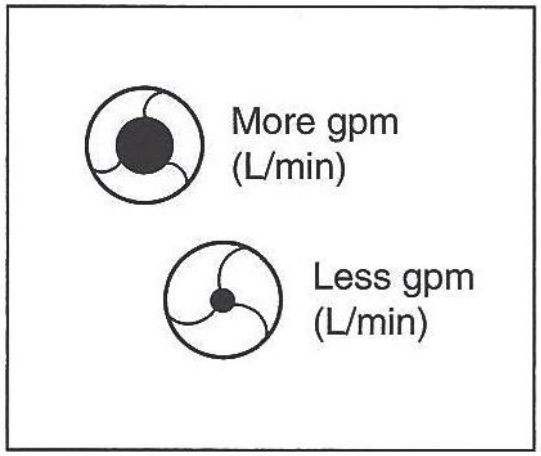


Impeller

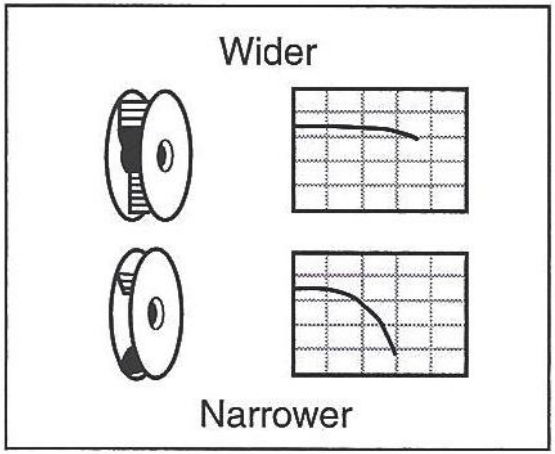

Discharge outlet
Impeller
Vane
Eye
Shaft


Front shroud
Vane
Back shroud
Shaft
Impeller eye

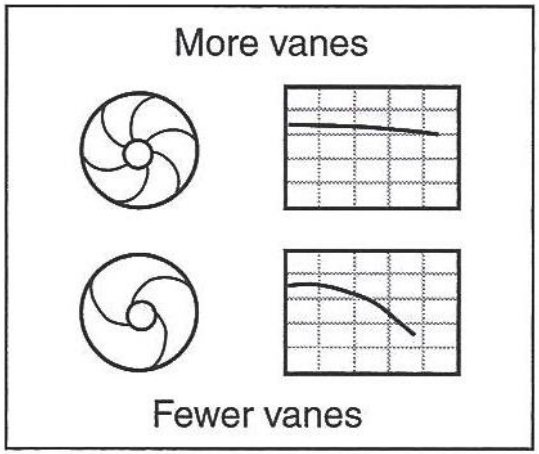
Flow Characteristics



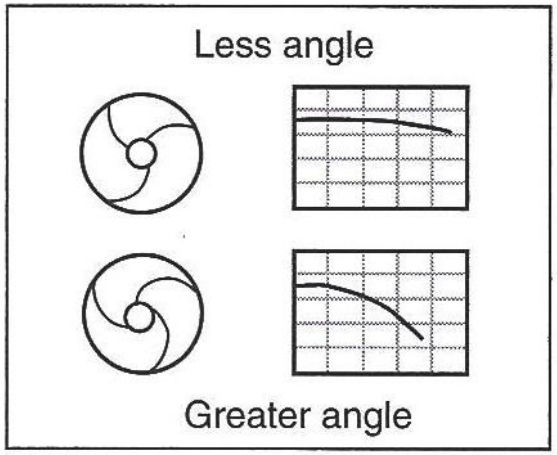
Diameter of eye



Width of impeller



Number of vanes



Angle of vanes

Other Pump Criteria

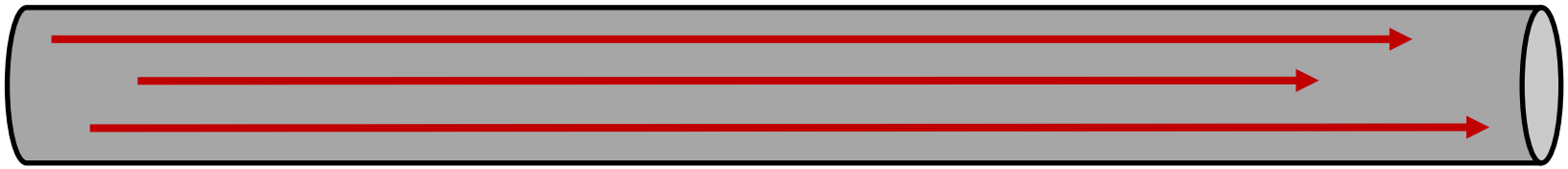
- Local water purveyors may have additional requirements that limit suction pressure to higher pressures (10 psi – 20 psi)

Low Suction Control Devices

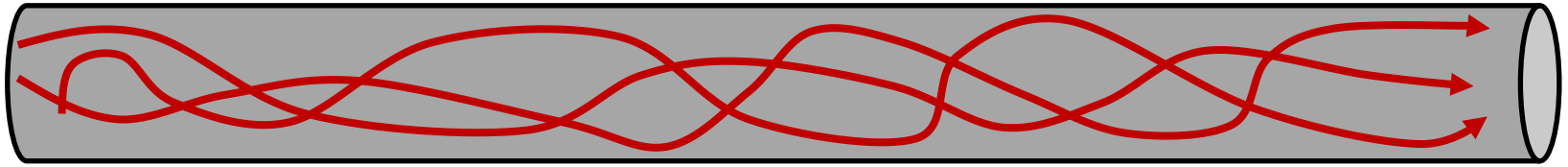
- Throttling Valve (Preferred Method per NFPA 20)
- Break Tank (NFPA 20 Criteria)
- Low Suction Control Units
- (Note: Low Suction Cutoff Devices that shut pumps down Do Not Comply With NFPA 20)

Section 4.14.9 – 4.15.9 – 4.31 (07) (10)

Laminar & Turbulent Flow



Laminar Flow



Turbulent Flow

Balanced &Unbalance Flow

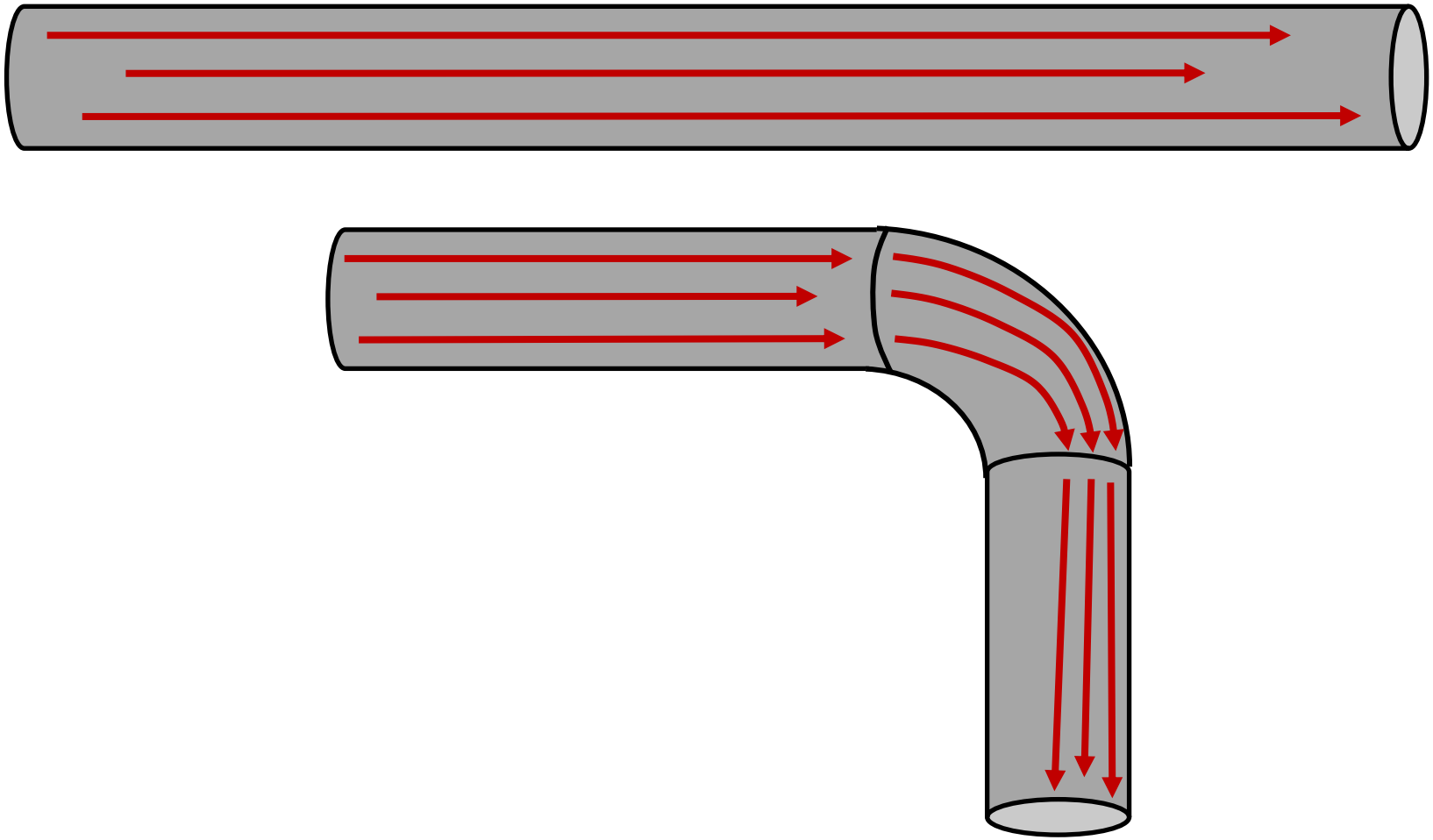
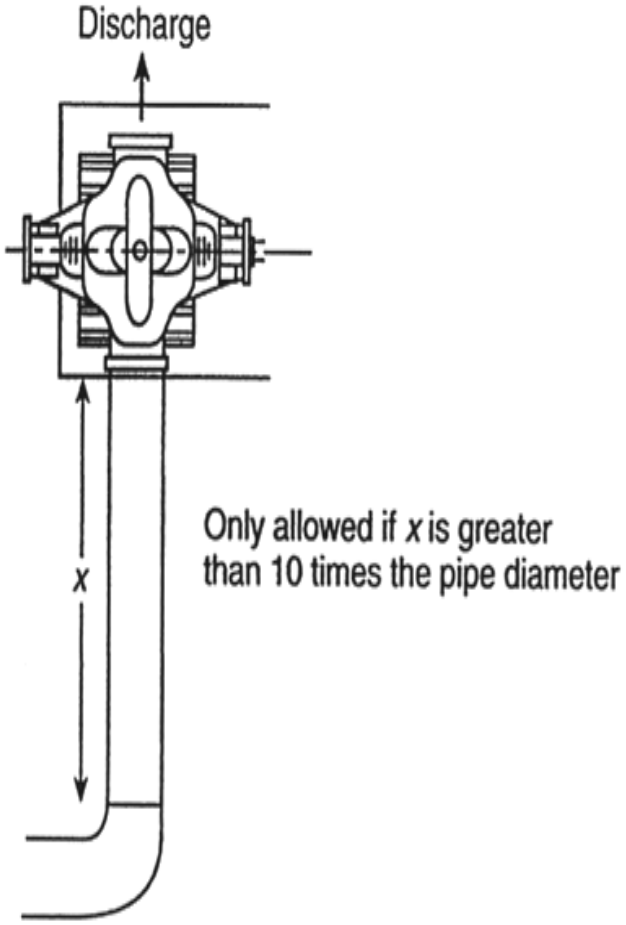
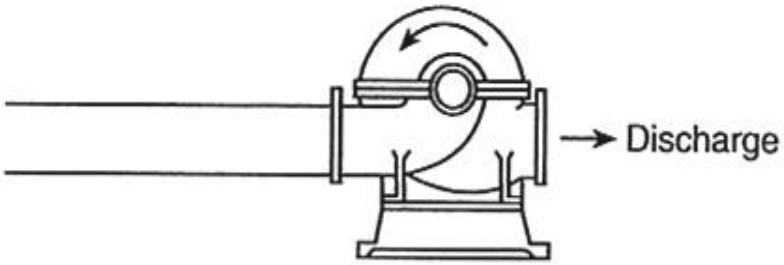


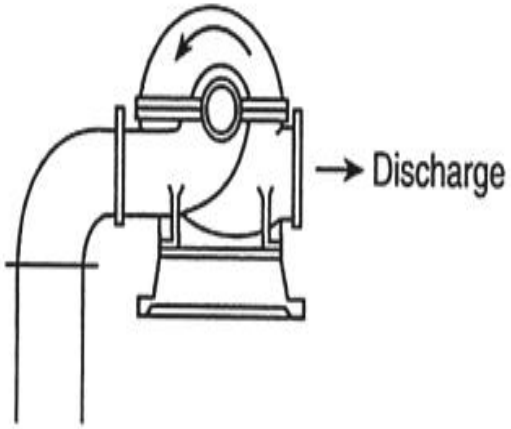
Figure 5-5 Suction pipe arrangements for horizontal split-case pumps



(b) Acceptable arrangement for a horizontal turn



(a) Preferred arrangement



(c) Acceptable arrangement for a vertical turn

Table 5.25b (03) (10 Times Rule)

TABLE 5-1 Acceptable Minimum Pipe Sizes

Pump Size		Minimum Nominal Pipe Size for Piping Close to Suction Flange		Minimum Distance *X* for Pipe Sized in Accordance with Previous Column	
gpm	L/min	in.	mm	ft-in.	m
250	950	3.5	90	2-11	0.9
500	1900	5	125	4-2	1.25
750	2850	6	150	5-0	1.5
1000	3800	8	200	6-8	2.0
1250	4750	8	200	6-8	2.0
1500	5700	8	200	6-8	2.0
2000	7600	10	250	8-4	2.5
2500	9500	10	250	8-4	2.5.

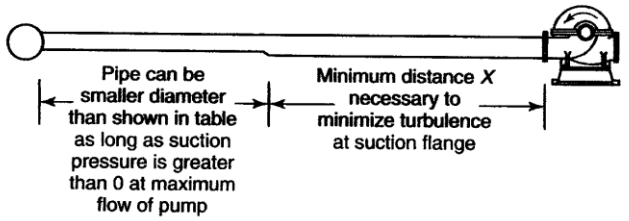


FIGURE 5-3 Suction pipe size.

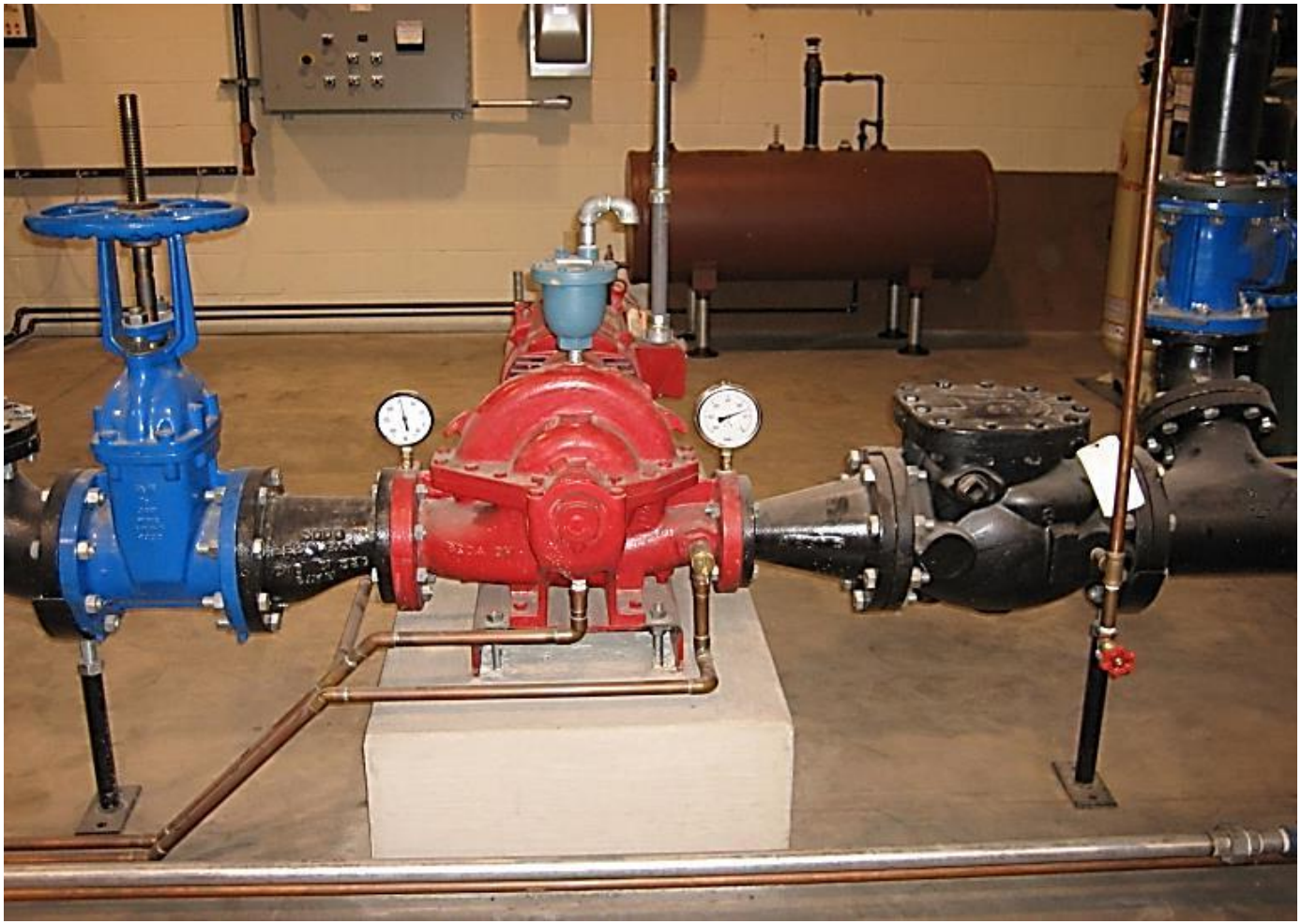
Section 4.27.3 (07) (10)

Balanced but Turbulent Flow

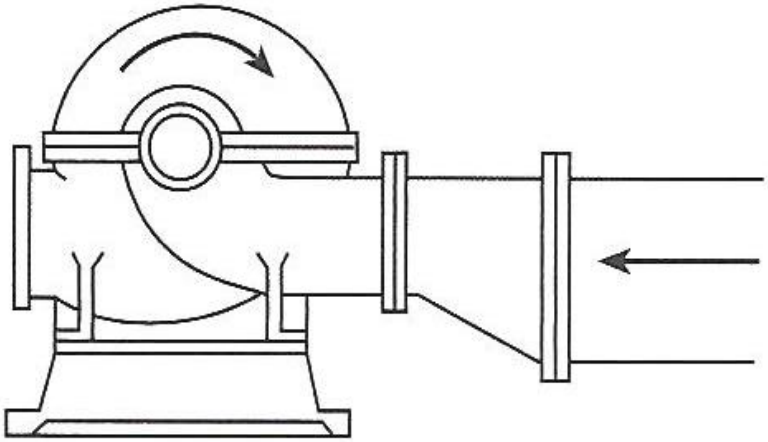
Installation

- Avoid air leaks and air pockets.
  - Air bubbles and unbalanced flow create problems for fire pump impeller
  - Increased corrosion
- Install air release valves when air pockets are unavoidable.

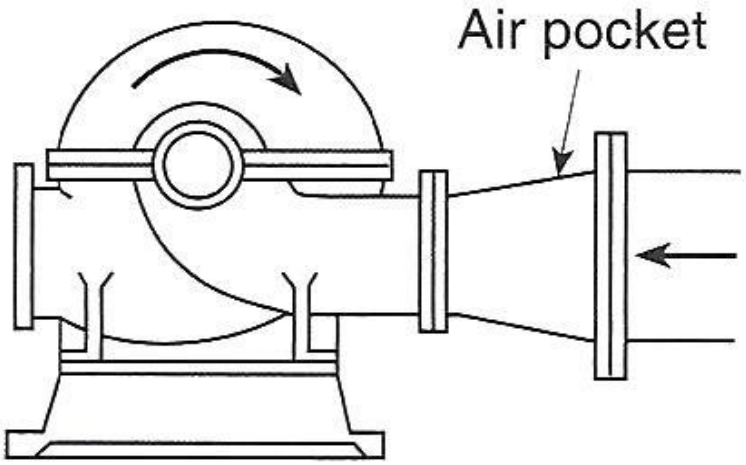
Eccentric Reducers



Use the Correct Reducer



Correct
Eccentric Reducer



Not Correct
Concentric Reducer

Suction Pipe

- Three ways water can enter the pump
  - Straight run to suction flange
  - Vertical bend into suction flange
  - Horizontal bend into suction flange

- Each can work, but different rules apply!

Straight Run or Vertical Bend

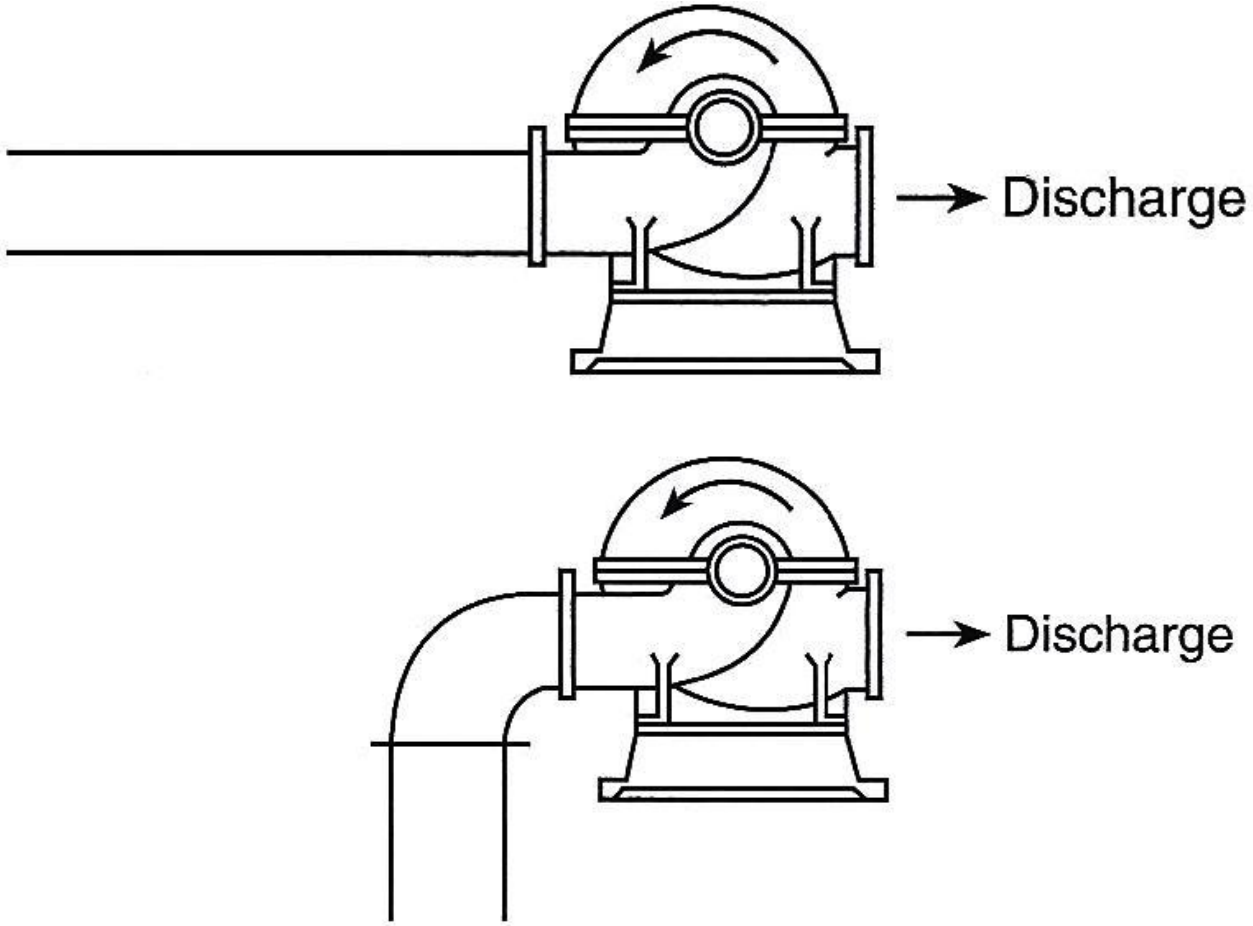


Figure A.4.14.6

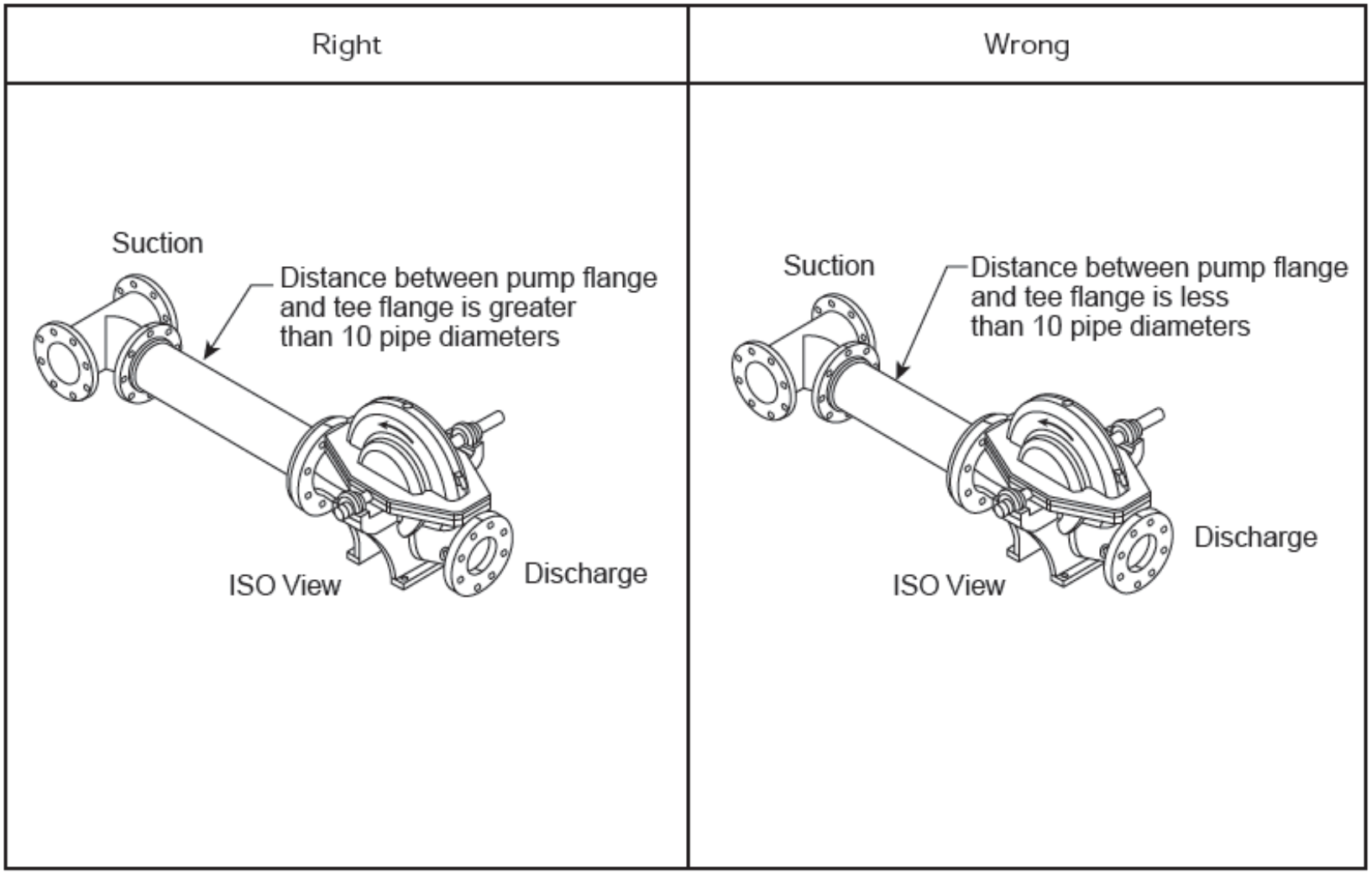


Figure A.4.14.6

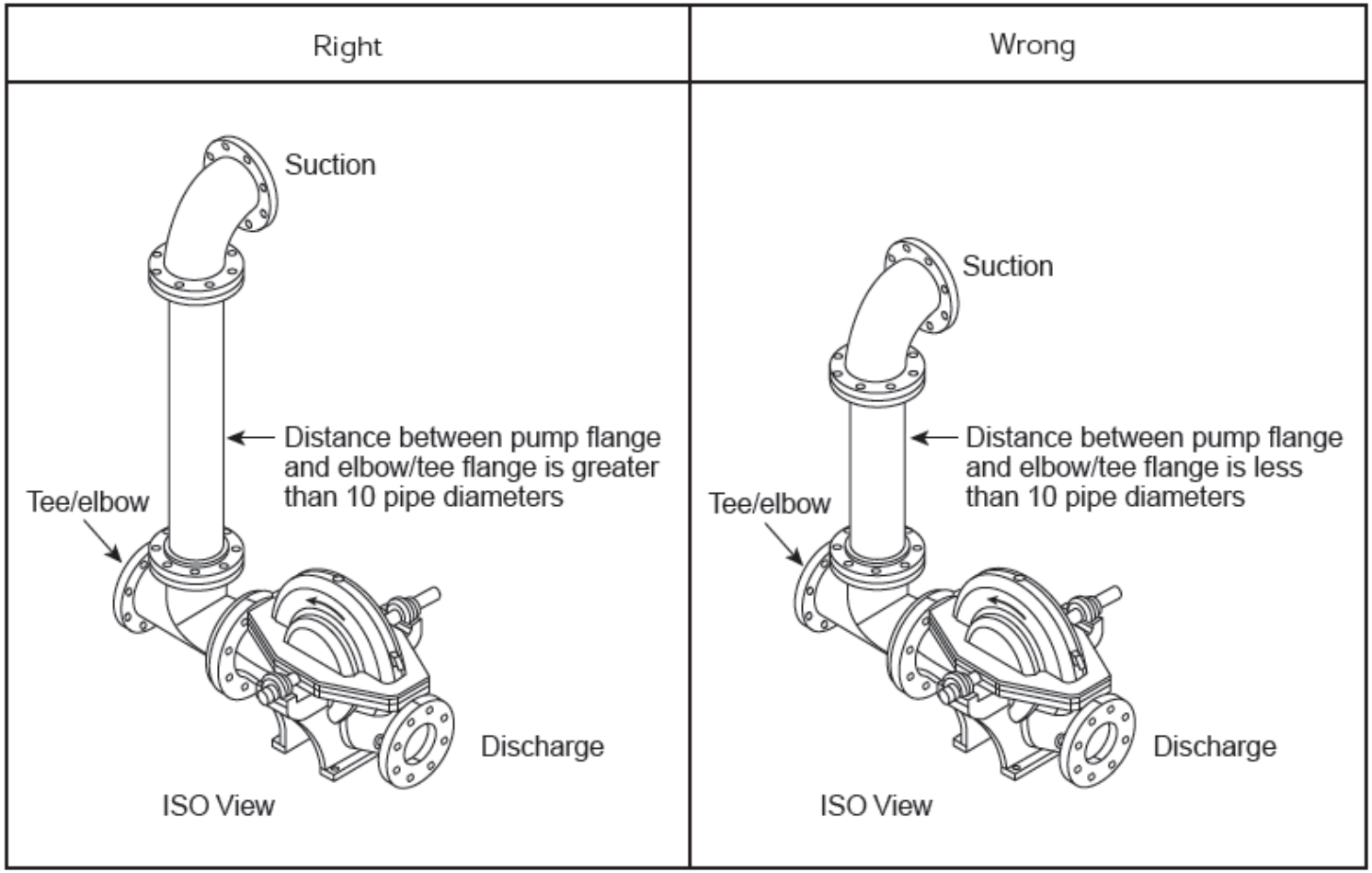
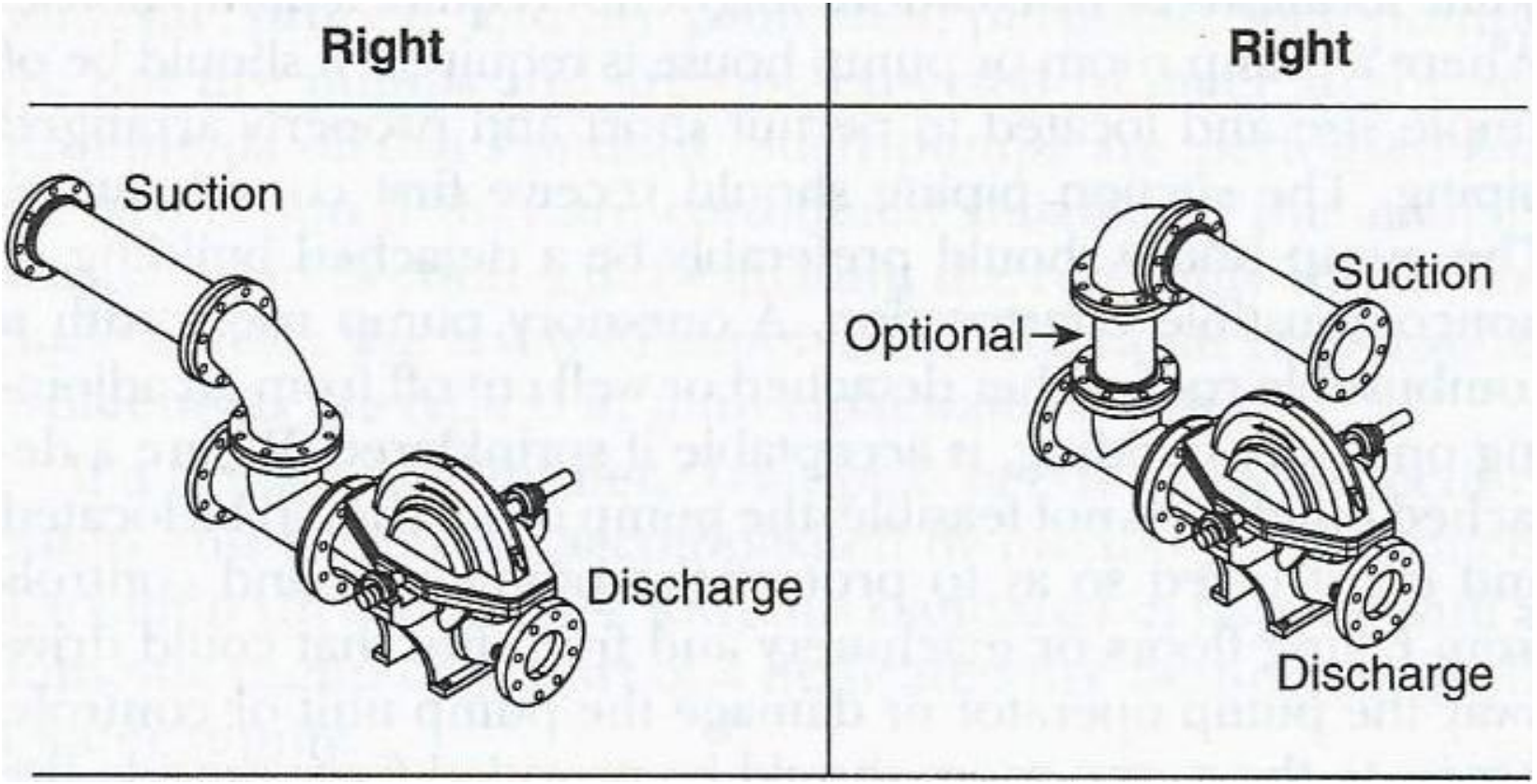
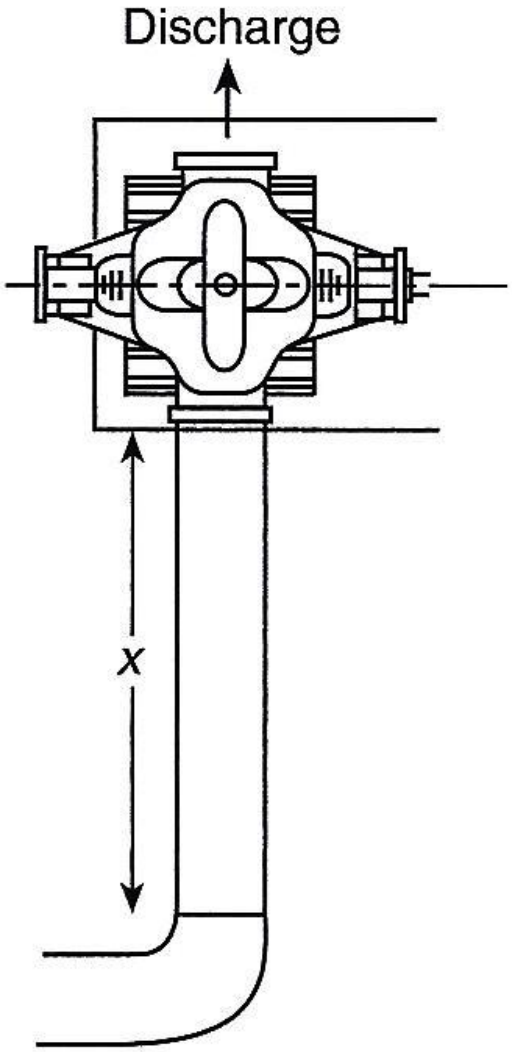


Figure A.4.14.6

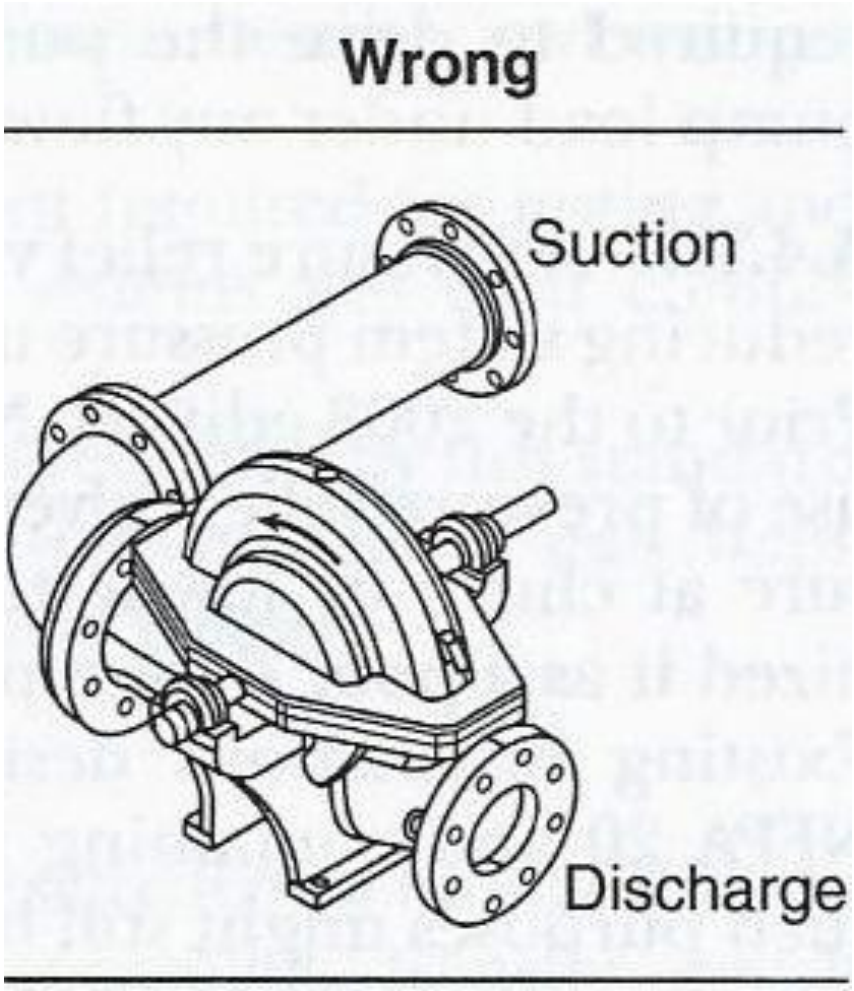


Horizontal Bend



Only allowed if the length, *x*, is greater than 10 times the pipe diameter

Figure A.4.14.6



Devices

- Check valves, backflow preventers shall be 10 pipe diameters from suction flange
- Backflow preventer with butterfly valves are permitted when located a minimum of 50 feet from suction flange.
- Pressure sensing line for low pressure
- Water level devices
- Suction strainers

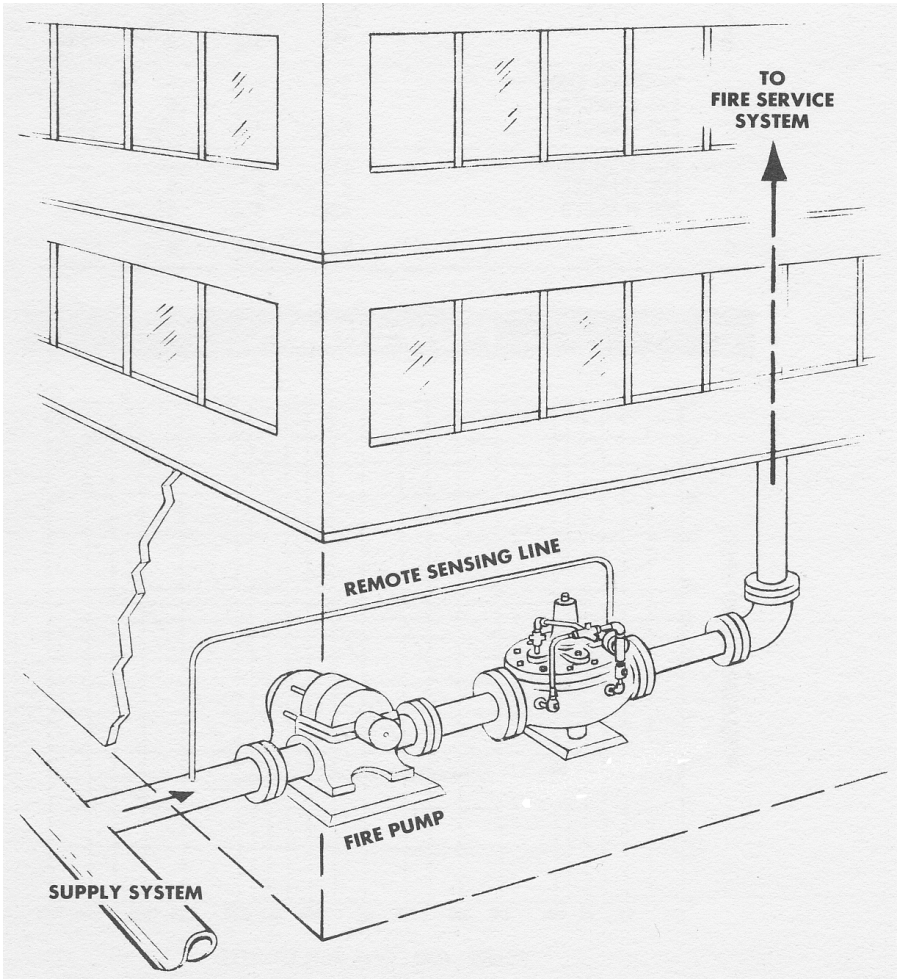
Devices in Suction Pipe

- Low Pressure Cut-off Devices
  - In suction piping
  - Monitors pressure
  - Closes if pressure gets too low
  - Not permitted by NFPA 20

Devices in Suction Pipe

- Low Pressure Throttling Devices
  - In discharge piping
  - Monitors pressure in suction piping
  - If pressure gets too low, partially closes but allows flow to continue
  - Allowed by NFPA 20

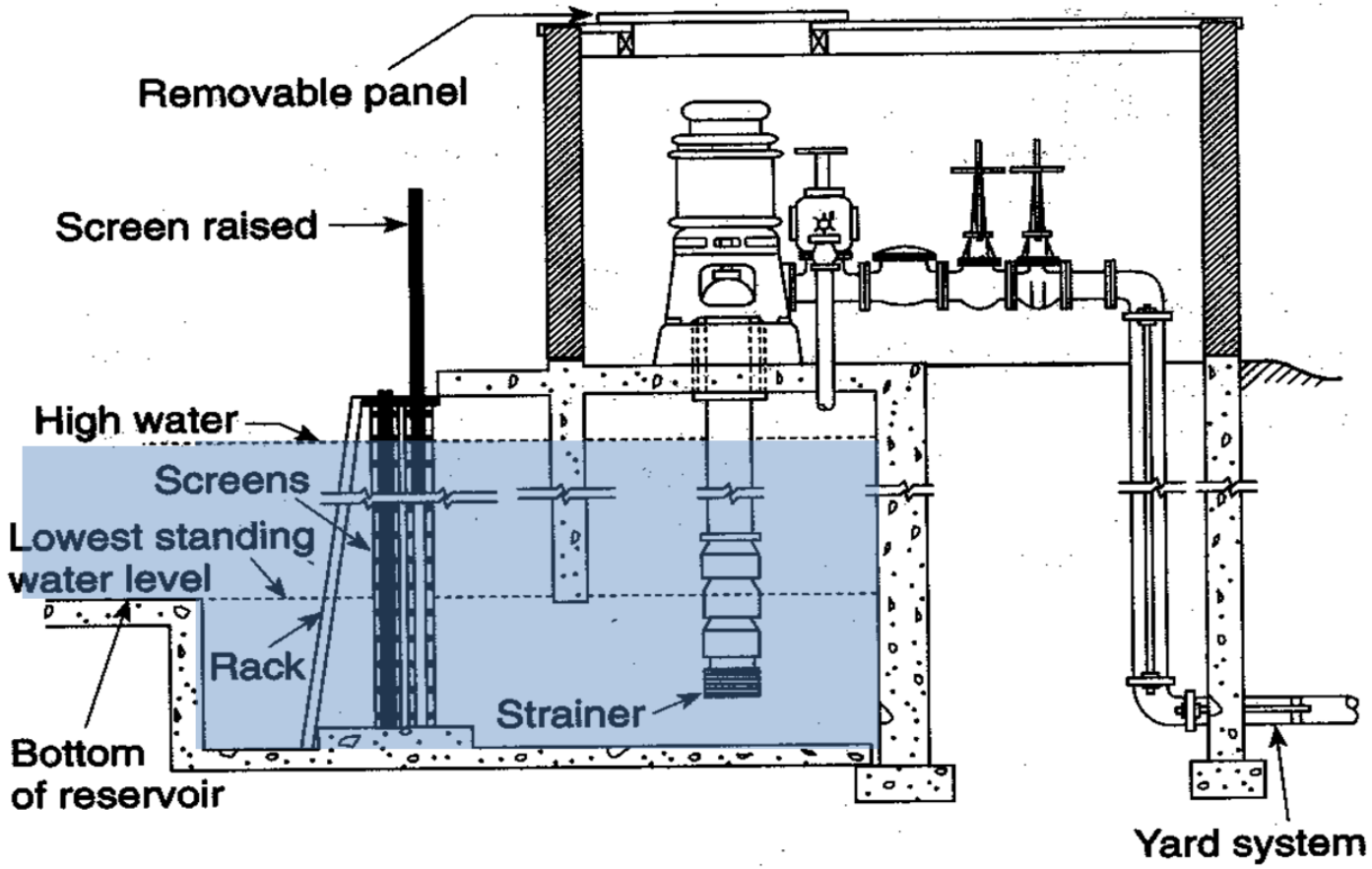
Low Suction Throttling Device



Fire Pump Layout

- Centrifugal fire pumps shall not be used where a static suction lift is required (suction side must be flooded)
- Section 6.1.2 – (03) (07) (10)

Vertical Shaft Turbine Pump



Fire Pump Sizing

- Pump Capacities
  - Churn – (0%)
  - Capacity – (100%)
  - Peak – (150%) –Exception for supply limitations, but must be able to supply system demand.
- Must remember that when the pump supply demand exceeds 100% of the discharge capacity, the discharge pressure capabilities decrease

Fire Pump Rated at 1000 GPM @ 80 PSI

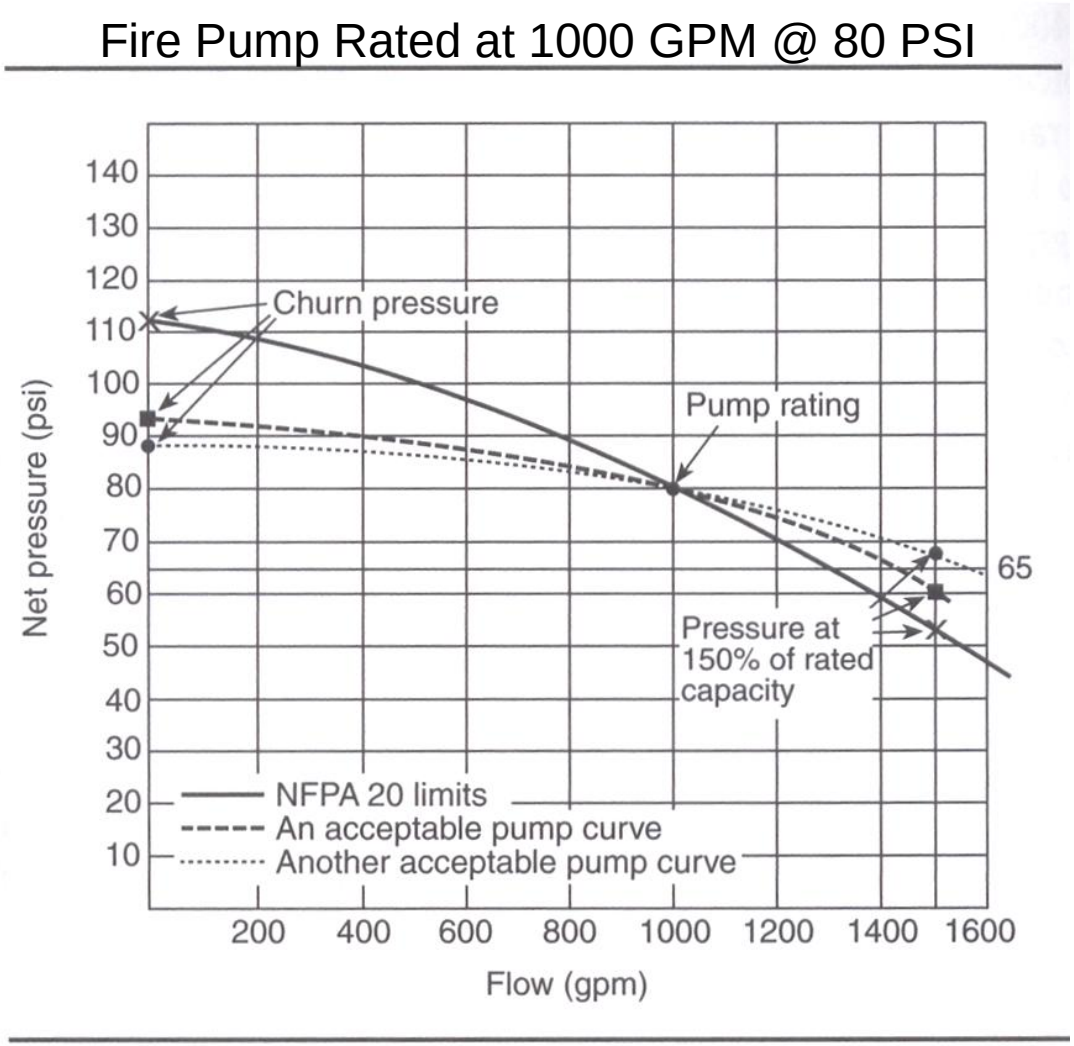


FIGURE 4-1 Acceptable flow curves for a 1000 gpm pump.

80 PSI Pump must provide a minimum of 52 PSI @ 150%

Fire Pump Sizing

- The estimated performance of the fire pump between 100% and 150% of rated flow can be calculated using the following formula:

- $y = -0.7x + 170$

  - x = Flow expressed as a percentage of rated flow
  - y = Pressure created by the pump (net pressure) expressed as a percent of rated pressure

Fire Pump Sizing

- Size selection normally varies from 90% to 140% pump capacity
- Normally once you exceed 125% capacity you will have to increase pump size to adjust for discharge pressure
  - Can not be less than system demand
  - Can not over pressure components
    - Lowest levels most significant problem
      - Can use variable speed drivers

Basic Hydraulics

- Flow - Volume of water moving through a system or past a point in a given period of time

  Measured in gpm or L/min
- Pressure - The energy available to do work, move water
  Measured in psi or bar
- Head - Another way of expressing energy based on equivalent height of a fluid column
  Measured in feet or meters

Pressure Head Relationship For Water

- If .433 psi = 1 foot or the inverse is 2.31 feet = 1 psi then;

$$P = 0.433 \times H$$

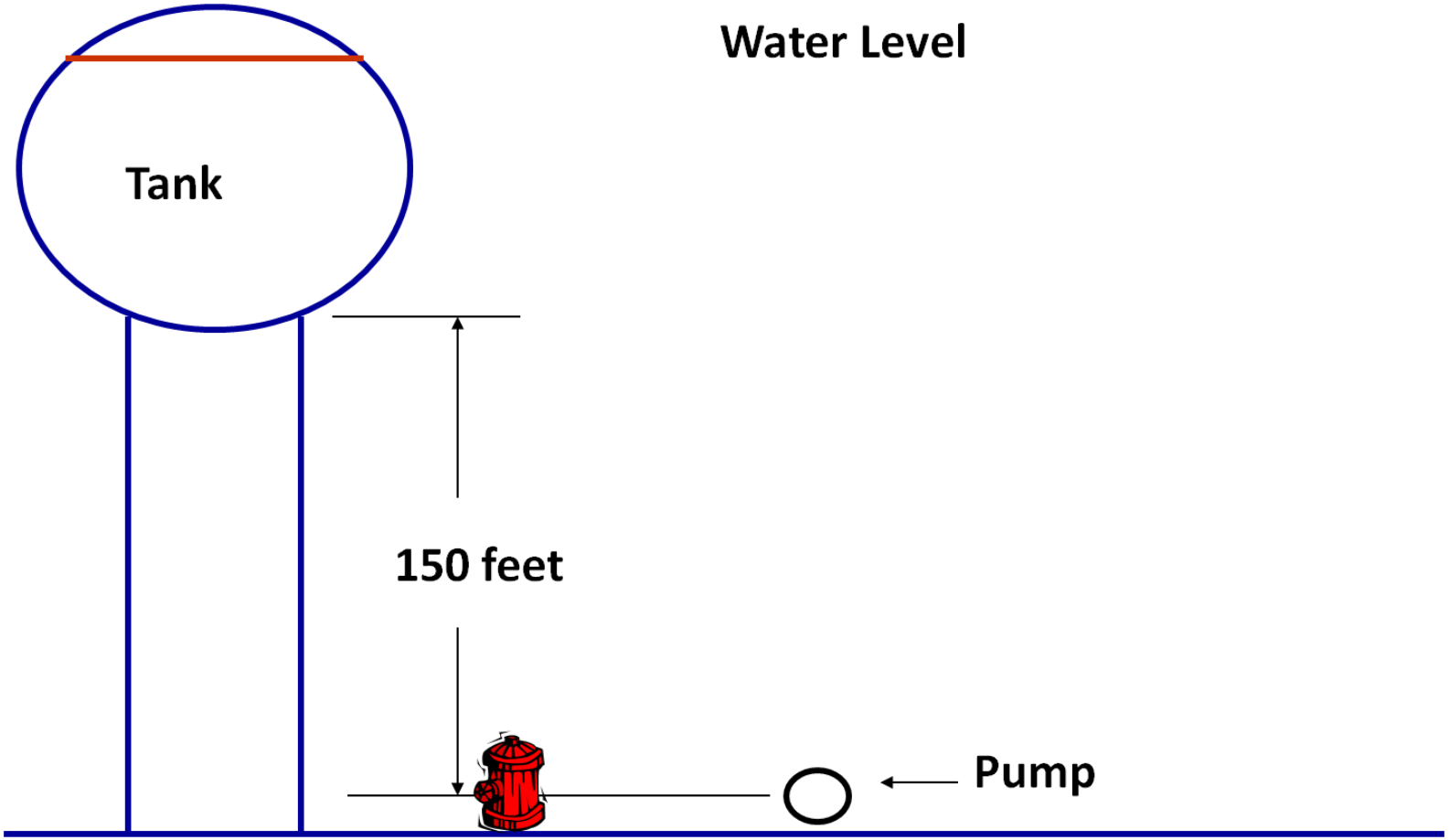
  - P = Pressure, in psi
  - H = Height, elevation of water in feet
- Inverse:

$$H = P \times 2.31$$

  - This can be used to determine the level of water in a tank if you have ability to gage at bottom of tank (hydrant)

Note: Older fire pumps are rated in feet head versus PSI

What pressure is available at the hydrant?



Answer

- P = 0.433 psi/ft X 150 ft

- P = 65 psi at fire hydrant

Suction Pressure Calculation

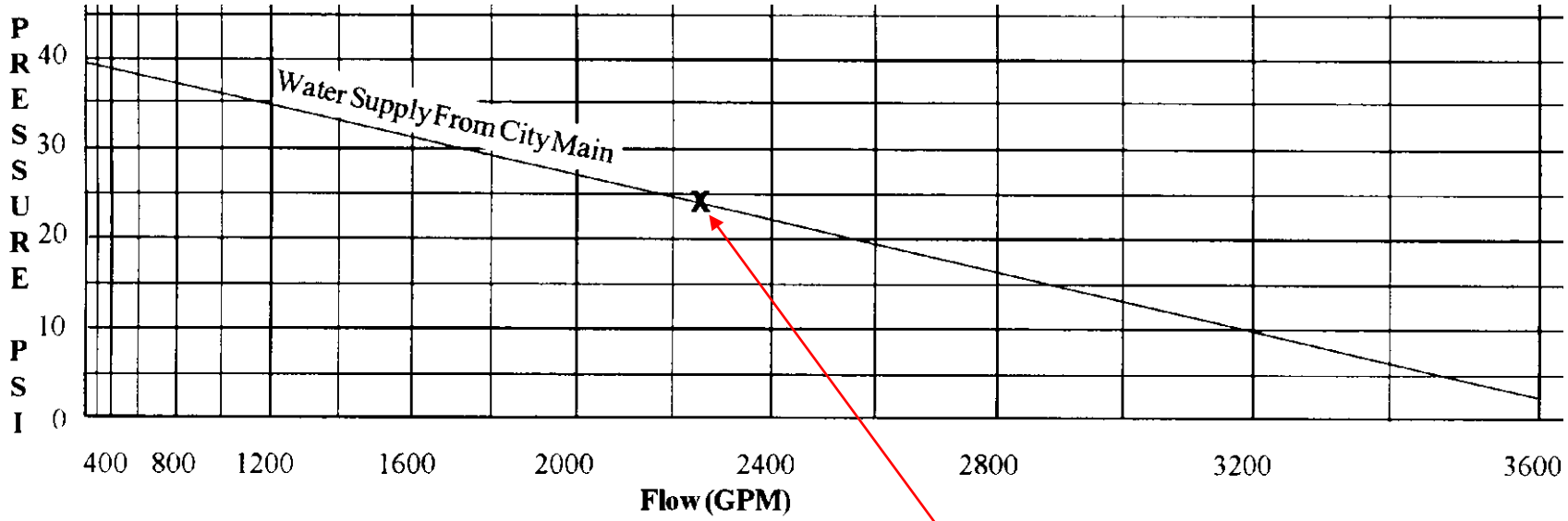
- Find the residual pressure of the water supply at the maximum flow for the pump at 150% of rated flow. Call this P_R
- Calculate all pressure loss for both friction and elevation between the water supply and the pump suction flange at the maximum flow for the pump. Call this P_L

Suction Pressure Calculation

- The suction pressure will be the residual pressure from the water supply minus the pressure losses.

$$P_S = P_R - P_L$$

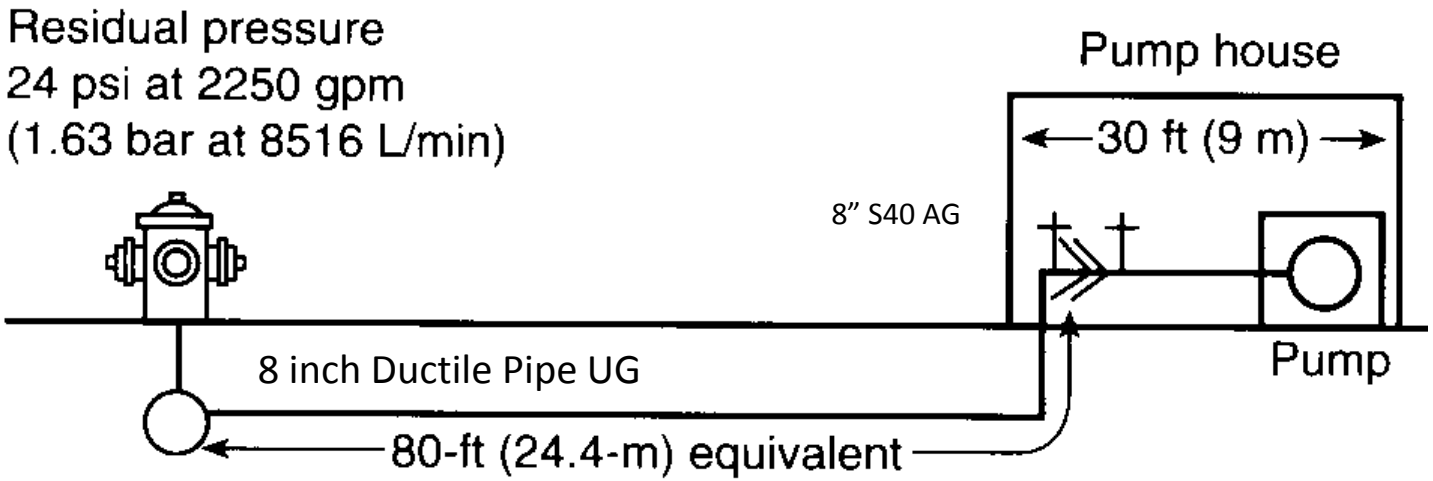
Suction Pressure Calculation



Supply curve indicates that there is 2250 GPM @ 24 PSI

Suction Pressure Calculation

Example: 1500 gpm Pump



Hazen Williams Formula

- Q = Flow / GPM
- C = Coefficient
- d = Inside Diameter

$$F_L = \frac{4.52\ Q^{1.85}}{C^{1.85} x\ d^{4.87}}$$

Example:

1500 gpm @ 100% / Ductile Iron/Class 54 UG (C=140) / 8 in. Diam.

$$\frac{4.52 \times 2250^{1.85}\ (150\%)}{140^{1.85} \times 8.15^{4.87}} = \frac{4.52\ x\ 1590514.59\ 4}{9339.785\ x\ 27373.955}$$

$$= \frac{7189125.96\ 5}{255666854.\ 3}$$

FL/per ft. = .028 psi per ft of pipe

FL in Underground Pipe = .028 psi/ft x 80 ft. = 2.24 psi

Hazen Williams Formula

- Q = Flow / GPM
- C = Coefficient
- d = Inside Diameter

$$F_L = \frac{4.52\ Q^{1.85}}{C^{1.85} x\ d^{4.87}}$$

$$\frac{4.52 \times 2250^{1.85}\ (150\%)}{140^{1.85} \times 8.15^{4.87}} = \frac{4.52\ x\ 1590514.59\ 4}{7022.395\ x\ 24718.328}$$

$$\frac{7189125.96\ 5}{173581863.\ 0}$$

F_L = 0.41 per ft of pipe

F_L in Aboveground Pipe = .041 psi/ft x 30 ft. = 1.23 psi

Suction Pressure Calculation

- Analysis at 2250 gpm (150% of 1500)
- Residual pressure = 24 psi (from graph)
- Friction loss in pump room piping (30 ft) = 1.2 psi
- Friction loss through underground (80 ft)= 2.24 psi
- Friction loss through backflow device = 8.0 psi (Provided by Manufacturer)
- Elevation loss (Same Elevation) = 0.0

PS = (24 psi Supply) – 2.24 – 1.2 – 8.0 – 0.0
PS = 12.56 psi available at suction flange

Estimate Approximate Pump Size

- Assumption 1
  Assume that the net pressure from the pump for any flow less than the rated flow will not be greater than the pump's rated pressure
- Assumption 2
  Assume the pump will produce a net pressure at churn of 140 % of its rated pressure
- Assumption 3

  Assume that the pump will produce a net 65% of its rated pressure at 150% of its rated flow

Fire Pump Layout

A ground level tank is being proposed to supply a 1000 gpm fire pump in a building with 300 feet of 8 inch schedule 30 steel pipe between the tank and pump (actual length plus fittings and valves). Is this arrangement acceptable?

Fire Pump Layout

The friction loss analysis should be preformed at 1500 gpm (150%). Using the Hazen-Williams formula, the friction loss between the tank and pump is 0.0185 psi per ft. producing a friction loss of 5.55 psi for the 300 feet of pipe. This situation is not acceptable because the suction pressure at the pump exceeds the acceptable pressure for suction tanks of -3 psi (0 – 5.55 = -5.55psi). The base of the tank needs to be elevated 5.89 feet (2.55 psi x 2.31 =5.890 feet). If this had been a raw water source such as a river the minimum acceptable suction pressure would have to be 0 psi.

Fire Pump Layout

- A vertical shaft turbine fire pump rated at 1000 gpm needs a screen to protect the wet pit that takes water from a lake. What is the minimum size the wet pit screen needs to be to comply with NFPA 20?

Fire Pump Layout

- The pump size needs to be entered into the equation A = 2.4 X Q (A = Area of screen sq. in. and Q = rated flow of pump). A =2.4 X 1000, or A = 2400 square inches of screen area.

- NFPA 20 states that you figure 1 square inch for each gallon of pump capacity based on 150% pump capacity and then multiply that figure by 1.6 which will give you the minimum required area of the screen or you can use the 2.4 X (100%) pump capacity which equals the same size area.

Fire Pump Sizing

- The fire pump is rated at 1000 gpm @ 100 psi, and it serves a ceiling only sprinkler system in an industrial facility with 35 feet between the pump center-line and the sprinklers. The maximum static pressure on the system is 60 psi. The pump net churn pressure is 130 psi. All components of the sprinkler system are rated at 250 psi, and the sprinklers are rated at 175 psi. Is this pump acceptable for the sprinkler system?

Fire Pump Sizing

- The fire pump will create a maximum discharge pressure of 190 psi at churn (130 + 60), which is acceptable for all system components (Less than 250). The pressure at the sprinklers while the pump is at churn condition can be calculated by subtracting the elevation pressure due to height of sprinklers from the pump discharge pressure (190 – 0.433 x 35 feet) or 190 psi – 15 psi = 175 psi.
- The pump is acceptable.

Fire Pump Sizing

- Consider a fire pump taking suction from a gravity tank, as illustrated in Figure #1. The bottom of the tank is 75 feet above the pump suction flange, and the pump is supplying a standpipe system with a demand of 1000 gpm @ 125 psi at the pump discharge. Determine what size fire pump should be used?

Fire Pump Sizing

System Demand

1000 gpm @

125 psi

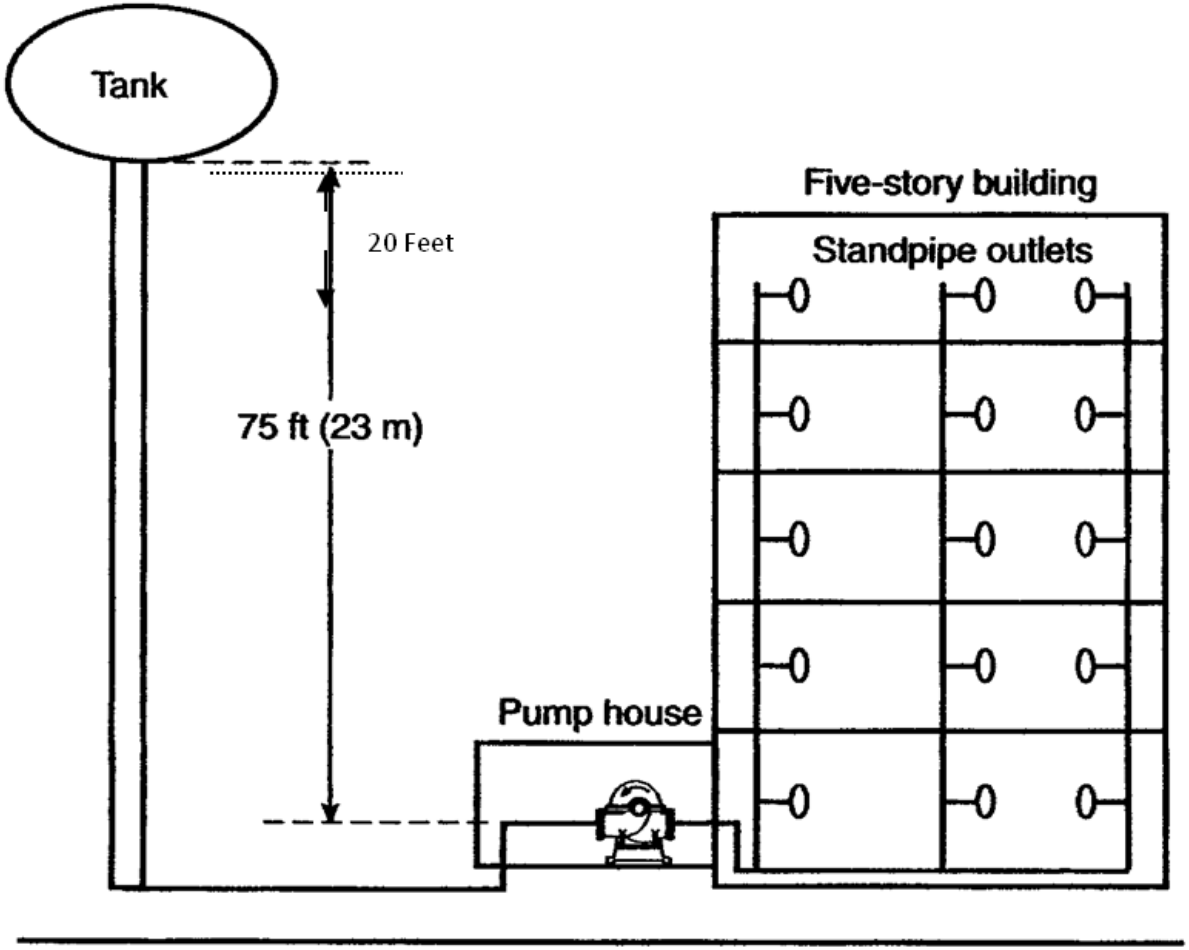
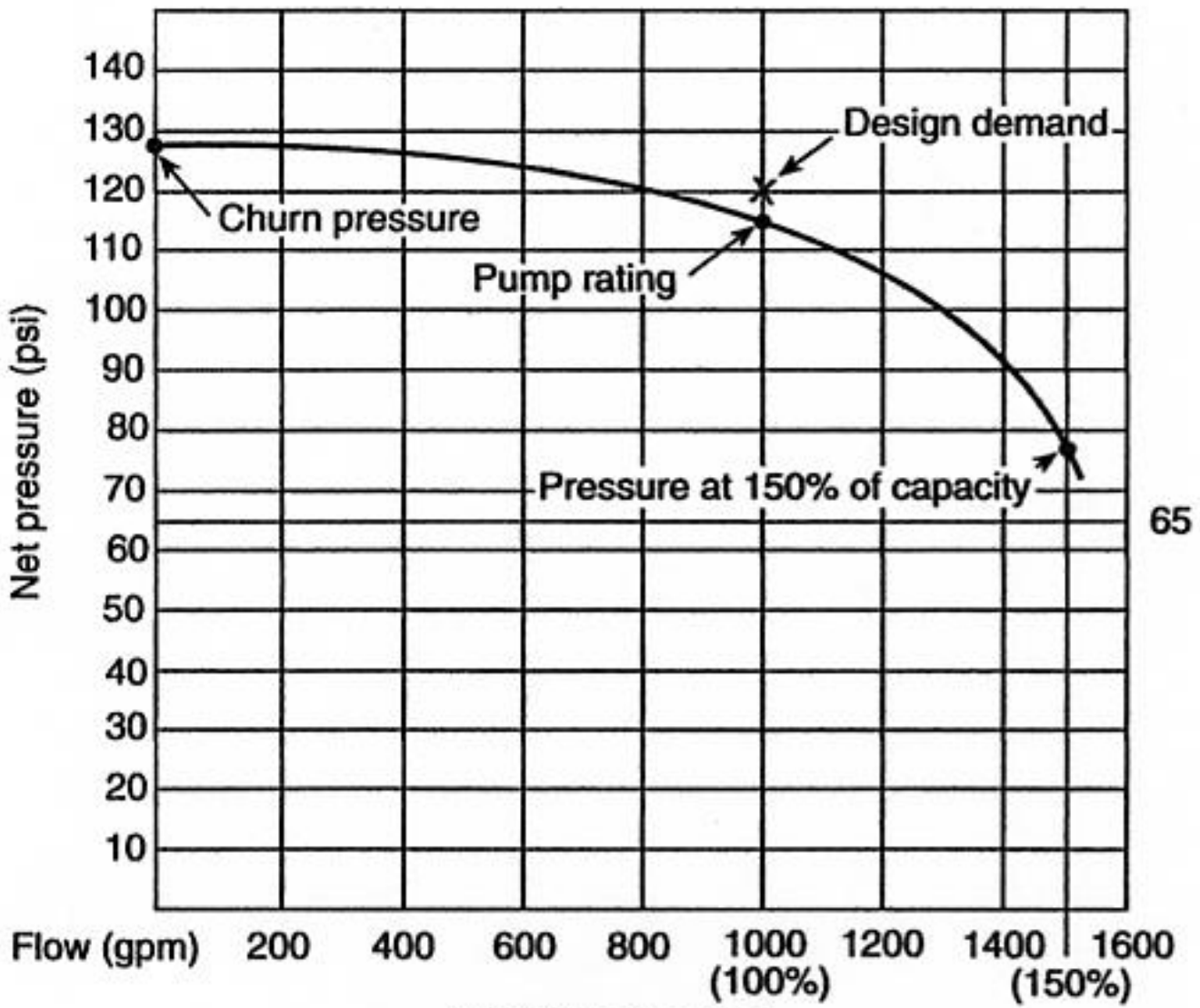


Figure 1

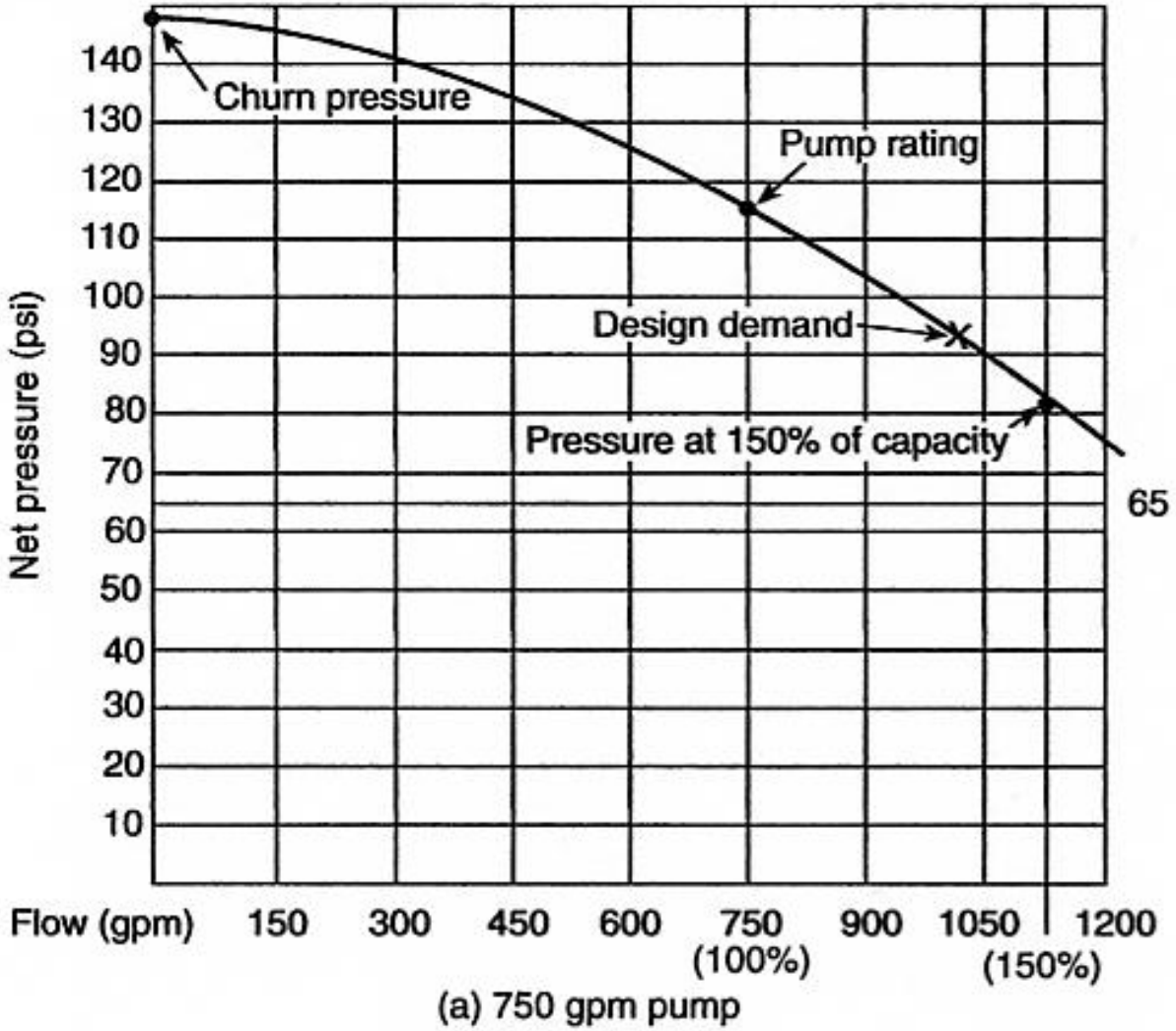
Fire Pump Layout

- Start with the pump flow characteristics. At best a 500 gpm pump could only provide 750 gpm, which is not enough. A 750 gpm pump could supply 1125 gpm, and may be a possibility, and a 1000 gpm pump could meet the supply demand, but may be an overkill for this situation. It is also necessary to examine actual manufacturer pressure curves for a specific model pump Figure # 2 shows the performance curve of a 750 and a 1000 gpm fire pump. Both pumps are rated at 115 psi.



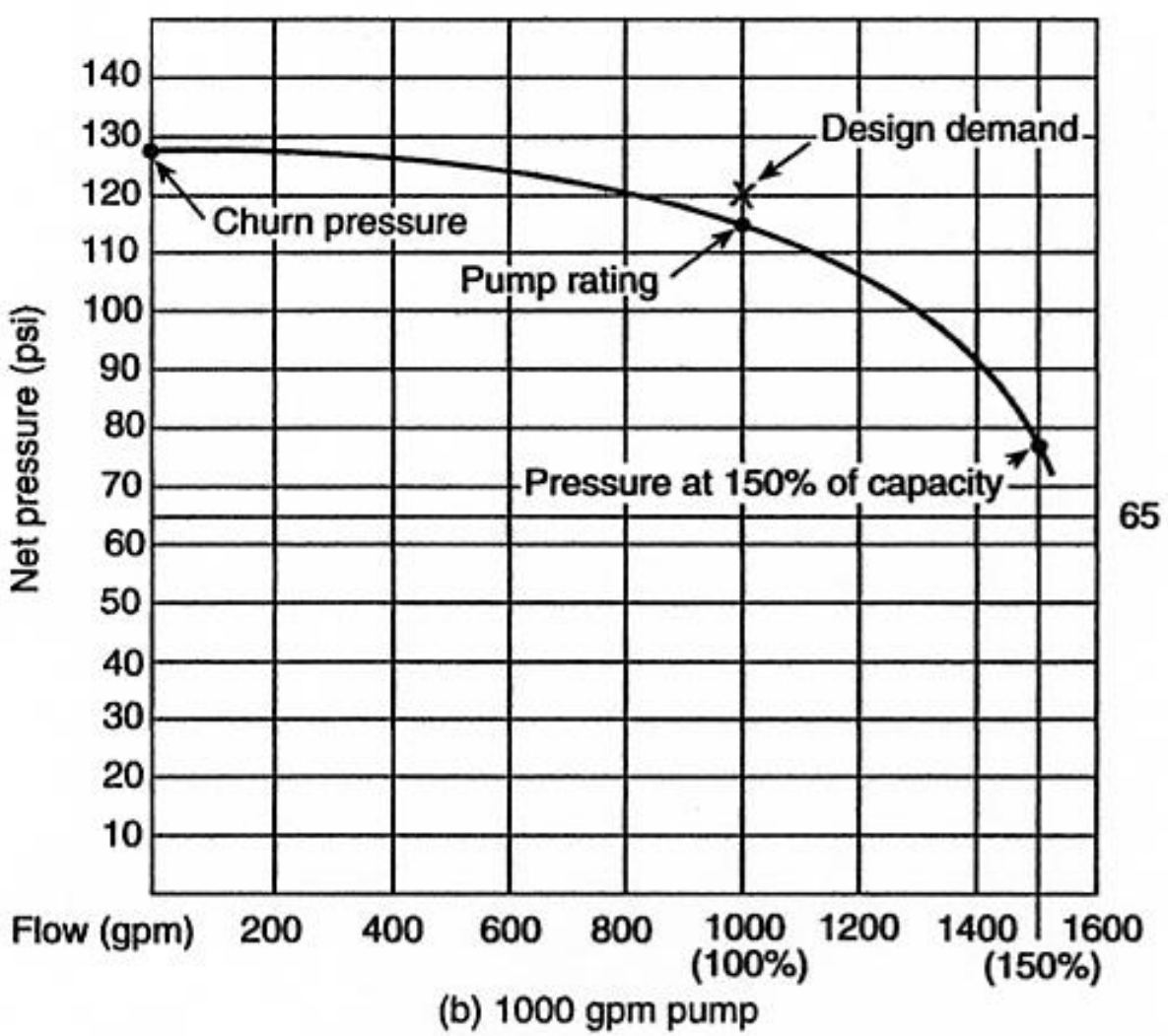
(b) 1000 gpm pump

Performance Curve



(a) 750 gpm pump

Performance Curve



(b) 1000 gpm pump

Fire Pump Layout (continued)

- The 750 pump will provide a 1000 gpm at approximately 92 psi net pressure (See Figure # 2 (a)) The tank will supply the water to the suction flange at 31 psi (75 x 0.433 – minus 1 psi for friction loss. Therefore the total discharge is 123 psi (92 + 31) at 1000 gpm which is not sufficient to supply the standpipe system's demand 125psi.

Fire Pump Layout (continued)

- Even if changes were made (Increase pipe sizes) so this pump will work, the layout technician needs to examine maximum pressures. The maximum static pressure from the water supply will be 40 psi (elevation of tank, assuming 20 feet higher than the bottom). The churn pressure of the pump is 149 psi. The maximum discharge pressure would be 189 psi (40 + 149). This might exceed rated pressures of the piping and fittings, thus not making the 750 gpm fire pump a good choice.

Fire Pump Layout (continued)

- The 1000 gpm pump will provide 1000 gpm at 115 psi net pressure (See Figure # 2 (b)). The tank providing water to the pump at the pump suction flange at 31 psi. Therefore the total discharge pressure is 146 psi (115 + 31) @ 1000 gpm (System demand is 1000 gpm @ 125 psi). The pump is acceptable to supply the standpipe. The maximum static pressure from the tank is 40 psi and the churn pressure is 129 resulting in a total discharge pressure of 170 psi, which is acceptable. Of the two pumps the 1000 gpm pump is the better choice.

Fire Pump Discharge Piping

- Discharge Piping requirements:

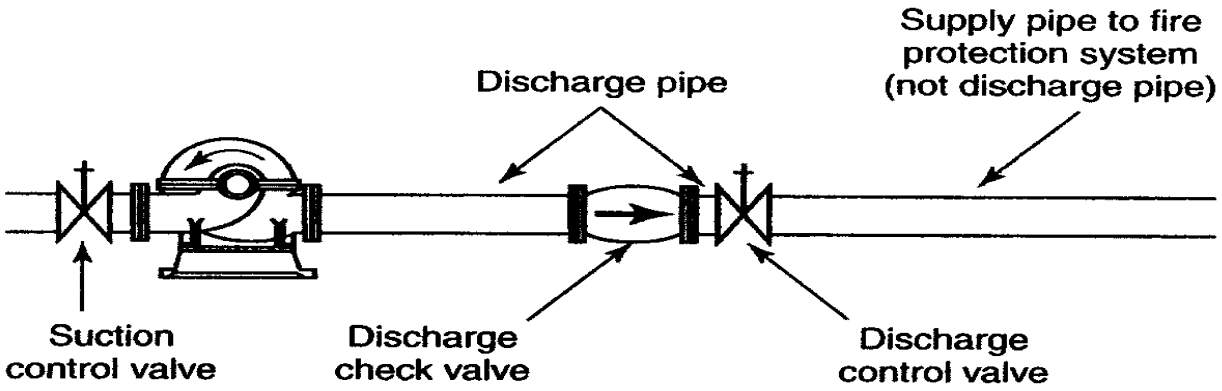


FIGURE 5-8 Discharge pipe and equipment.

Table 5.25b (03)

TABLE 5-3 Minimum Discharge Pipe Sizes

Pump Size		Minimum Nominal Pipe Size for Discharge Piping	
gpm	L/min	in.	mm
250	950	3	75
500	1900	5	125
750	2850	6	150
1000	3800	6	150
1250	4750	8	200
1500	5700	8	200
2000	7600	10	250

Pump Ratings (GPM)	Table 4.26 (a) Minimum Pipe Size (in.)						
	Suction	Discharge	Relief Valve	Relief Valve Dis.	Meter Device	# & Size Hose Valves	Hose Header Supply
50 -200	See Table 4.26 (a)						
250	3 ½	3	2	2 ½	3 ½	1-2 ½	3
500	5	5	3	5	5	2-2 ½	4
750	6	6	4	6	5	3- 2½	6
1000	8	6	4	8	6	4-2 ½	6
1250	8	8	6	8	6	6-2 ½	8
1500	8	8	6	8	8	6-2 ½	8
2000 – 5000	See Table 4.26 (a)						

Fire Pump Test Header Layout

- Discharge Piping and hose valve requirements:

Test Flows with Pitot Gauge

Table 5.25b (03)

TABLE 5-6 Minimum Test Header Pipe Sizes

Pump Size		Minimum Nominal Size for Pipe to Test Header [use one size larger if distance exceeds 15 ft (4.5 m)]		Minimum Number of Hose Connections for Test Header
gpm	L/min	in.	mm	
250	950	3	75	1
500	1900	4	100	2
750	2850	6	150	3
1000	3800	6	150	4
1250	4750	8	200	6
1500	5700	8	200	6
2000	7600	8	200	6
2500	9500	10	250	8

Pump Ratings (GPM)	Table 4.26 (a) Minimum Pipe Size (in.)						
	Suction	Discharge	Relief Valve	Relief Valve Dis.	Meter Device	# & Size Hose Valves	Hose Header Supply
50 -200	See Table 4.26 (a)						
250	3 ½	3	2	2 ½	3 ½	1-2 ½	3
500	5	5	3	5	5	2-2 ½	4
750	6	6	4	6	5	3- 2½	6
1000	8	6	4	8	6	4-2 ½	6
1250	8	8	6	8	6	6-2 ½	8
1500	8	8	6	8	8	6-2 ½	8
2000 – 5000	See Table 4.26 (a)						

Closed Loop Metering

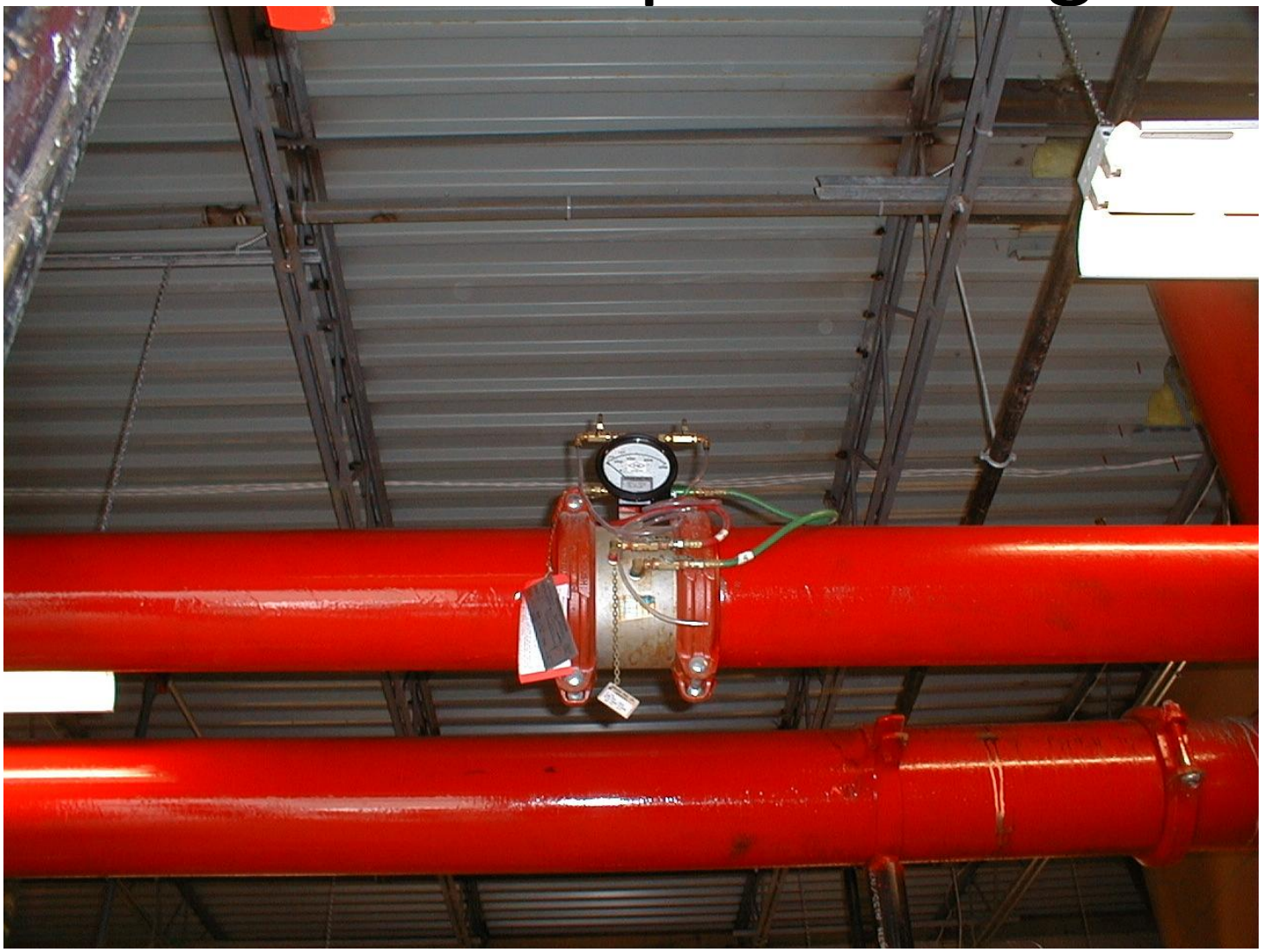


Table 5.25b (03)

TABLE 5-7 Minimum Flow Meter and Pipe Sizes

Pump Size		Minimum Nominal Size for Pipe and Flow Meter [use one size larger if equivalent length exceeds 100 ft (30 m)]	
gpm	L/min	in.	mm
250	950	3.5	90
500	1900	5	125
750	2850	5	125
1000	3800	6	150
1250	4750	6	150
1500	5700	8	200
2000	7600	8	200
2500	9500	8	200

Pump Ratings (GPM)	Table 4.26 (a) Minimum Pipe Size (in.)						
	Suction	Discharge	Relief Valve	Relief Valve Dis.	Meter Device	# & Size Hose Valves	Hose Header Supply
50 -200	See Table 4.26 (a)						
250	3 ½	3	2	2 ½	3 ½	1-2 ½	3
500	5	5	3	5	5	2-2 ½	4
750	6	6	4	6	5	3- 2½	6
1000	8	6	4	8	6	4-2 ½	6
1250	8	8	6	8	6	6-2 ½	8
1500	8	8	6	8	8	6-2 ½	8
2000 – 5000	See Table 4.26 (a)						

7 Steps to Pump Sizing

1. Calculate system demand to pump discharge flange

2. Calculate water supply to pump suction flange

3. Select pump so that the system flow demand is less than 150% of the rated flow of the pump (less than 140% recommended)

7 Steps to Pump Sizing

4. Using the Manufacturer's Pump Curve, find the pump's net pressure at the system demand flow

5. Add the suction pressure (at demand flow) to the net pressure (at demand flow) to get the discharge pressure (at demand flow)

7 Steps to Pump Sizing

6. If the discharge pressure is greater than the demand, okay. If not, select new pump.

7. Check maximum pressure produced by pump and make sure that the pump does not create more pressure than the equipment can handle

Fire Pump Sizing

- In Summary:
  - Must meet fire protection system demand (GPM & PSI)
    - Based on available water supply
    - Without over sizing
    - Without under sizing
  - Must not over pressurize system components
    - Avoid use of pressure relief valves
  - Must meet minimum suction requirements
    - 0 psi
    - -3 psi suction tank
    - Water purveyors requirements
  - Must it fit in the space allowed

Annex Material

- Fire Pump Plan Review Sheet
- Fire Pump Acceptance Testing Sheet
- Electric Fire Pump Test Data Sheet
- NFSA Fire Pump Acceptance Criteria

Learning Outcomes

- Identify the appropriate sections of NFPA 20 that apply to sizing and layout of fire pumps.
- Identify the components of a fire pump and driver.
- Describe the purpose of the various components of a fire pump and driver.
- Describe the steps necessary for appropriately sizing a fire pump
- Discuss the variables that impact the layout of a fire pump and how they are addressed

Thank you