Continuing Education for the Fire Fighter

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Fire Streams

Module 1

Chapter 16

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LEARNING OBJECTIVES

Explain the way vaporization and steam relate to the extinguishing properties of water.

Identify the factors that create pressure loss or gain.

Describe the impact water hammer has on fire streams.

Explain fire stream patterns and their possible limiting factors.

Describe the three types of fire stream nozzles.

Compare the different types of nozzle control valves.

LEARNING OBJECTIVES

Describe the factors in operating and maintaining handline nozzles.

Operate a fog-stream nozzle.

Operate a broken-stream nozzle.

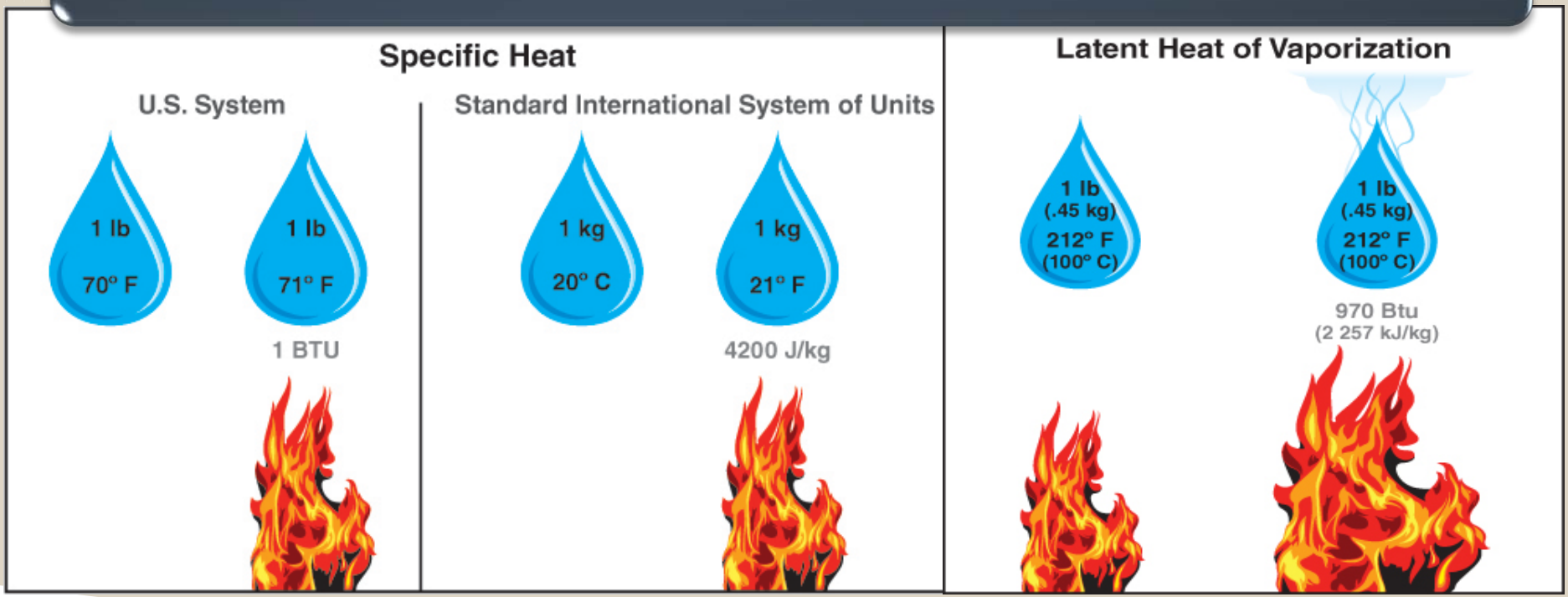
Operate a solid stream nozzle.

WATER HAS SEVERAL CHARACTERISTICS THAT MAKE IT VALUABLE FOR EXTINGUISHMENT.

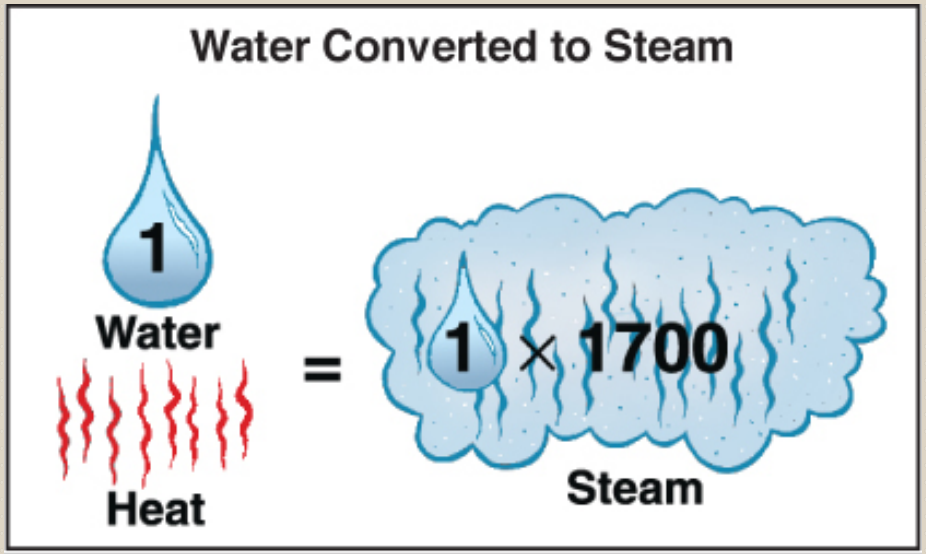
- Readily available
- Relatively inexpensive
- High specific heat
- High latent heat of vaporization
- Applied in variety of ways

VAPORIZATION OCCURS WHEN WATER THAT IS HEATED TO BOILING POINT CONVERTS TO VAPOR OR STEAM.

Energy required to change state of water

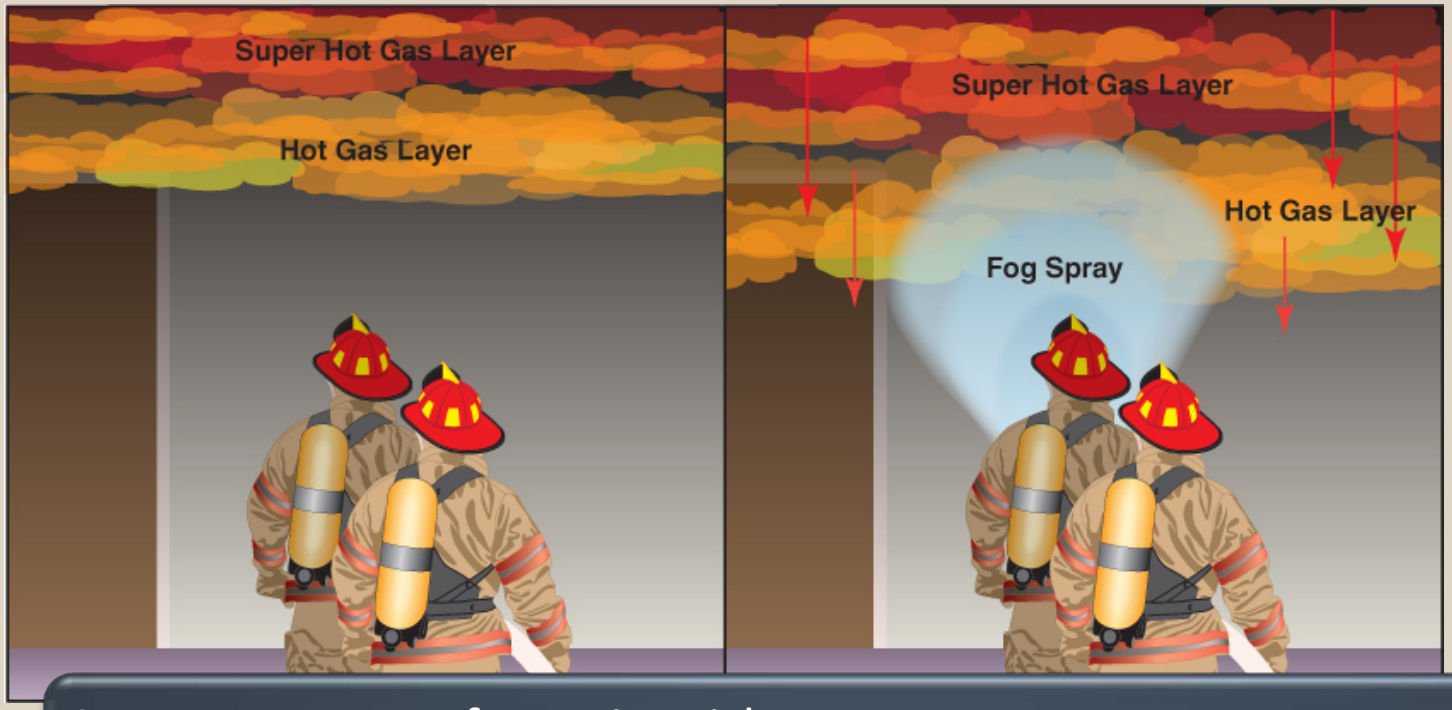


FIREFIGHTERS NEED TO UNDERSTAND THE BASIC PROPERTIES OF STEAM.



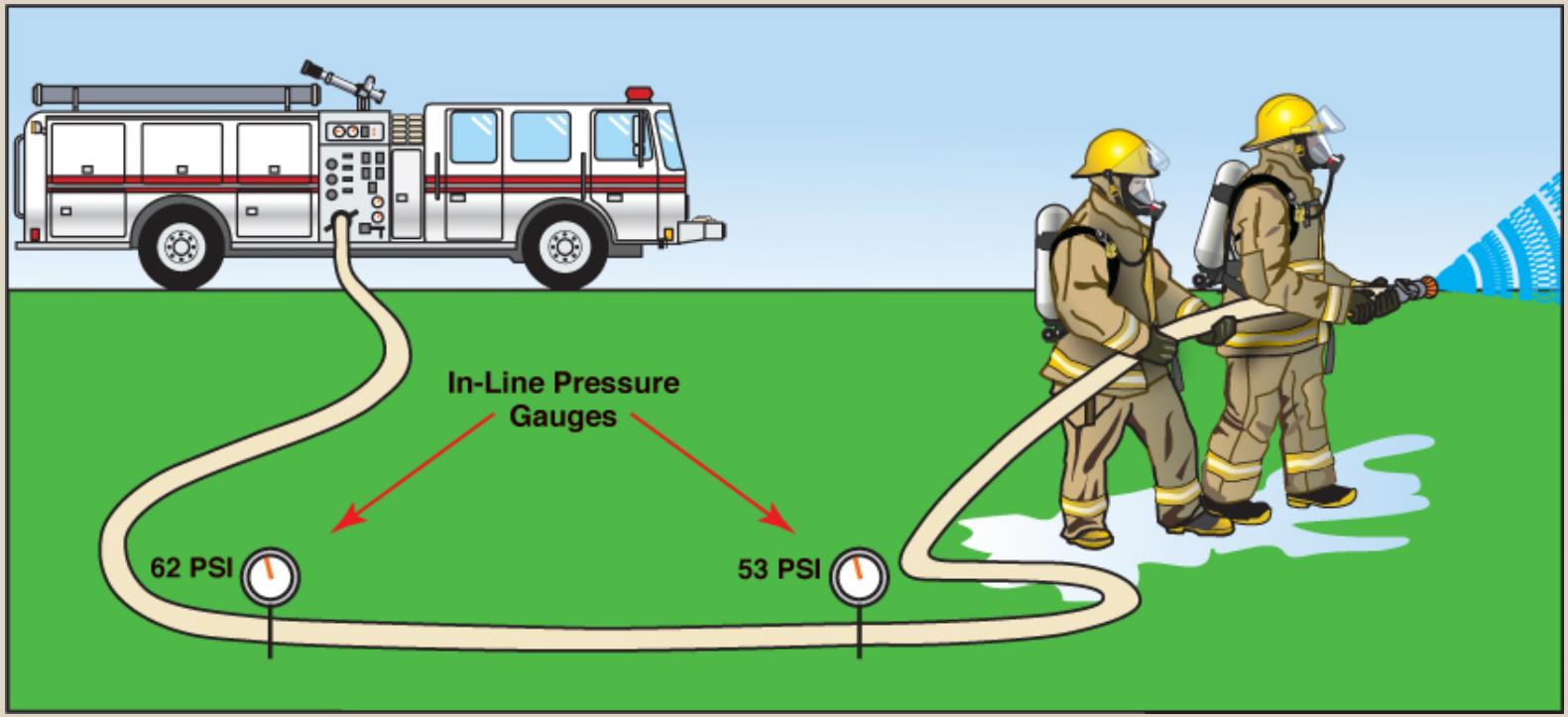
Complete vaporization requires boiling temperatures be maintained

FIREFIGHTERS NEED TO UNDERSTAND THE BASIC PROPERTIES OF STEAM.



Steam necessary for extinguishment –
Care must be taken to apply in right place

THE PRINCIPLES OF FRICTION LOSS WILL IMPACT WATER PRESSURE ON SCENE.



OTHER ON SCENE COMPONENTS WILL IMPACT FRICTION LOSS.

Practical limits to velocity of water in hoseline

Length of hose lay

Hose size, length of hose lay

Number of adapters

Rough linings in fire hose

Sharp bends in hose

Damaged hose couplings

SOME ACTIONS CAN OVERCOME OR REDUCE FRICTION LOSS.

Overcome by	Reduce by
• Increasing hose size • Adding parallel hoselines • Increasing pump pressure	• Taking out kinks, sharp bends in hoselines

THE DIFFERENCE IN ELEVATION BETWEEN THE NOZZLE AND PUMPING APPARATUS CAUSES ELEVATION PRESSURE.

Courtesy of Bob Esposito

WATER HAMMER IS PRESSURE CREATED WHEN THE NOZZLE IS CLOSED SUDDENLY.

Shock wave produced
- Pressure surge results

Creates excessive pressures
- Can cause damage

Flow rates
- Minimal at low flow
- Higher rates increase

To prevent – Close slowly
- Nozzles
- Hydrants
- Control valves
- Hose clamps

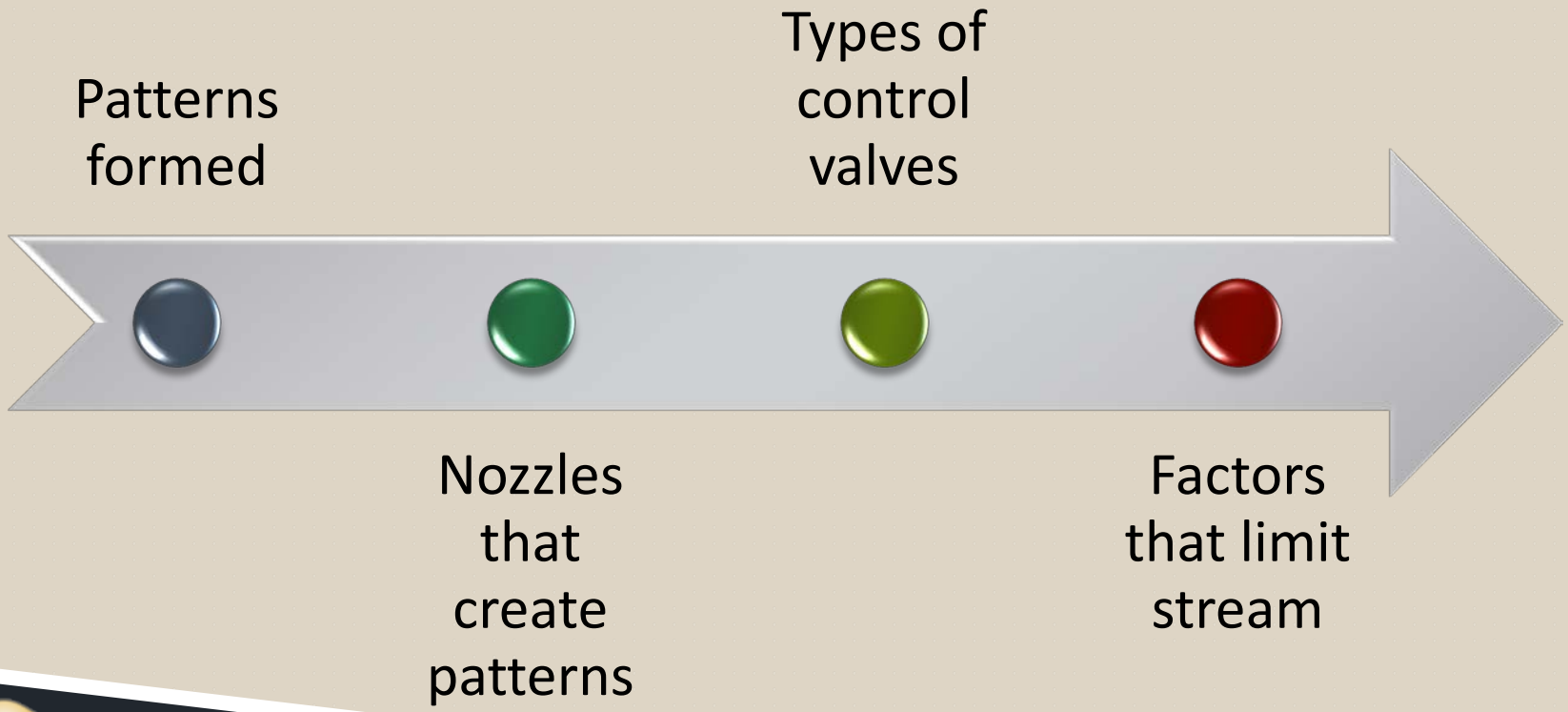
SEVERAL FACTORS AFFECT A STREAM OF WATER OR EXTINGUISHING AGENT FROM A NOZZLE.

- Velocity of water
- Gravity
- Wind direction, velocity
- Air friction
- Operating pressure
- Nozzle design and adjustment
- Condition of nozzle opening

FIRE STREAMS ARE USED TO ACCOMPLISH SEVERAL GOALS.

- Apply to burning material
- Apply to open flames
- Reduce temperature of upper layers
- Disperse hot smoke, fire gases
- Create water curtain to protect
- Create barrier between fuel and fire

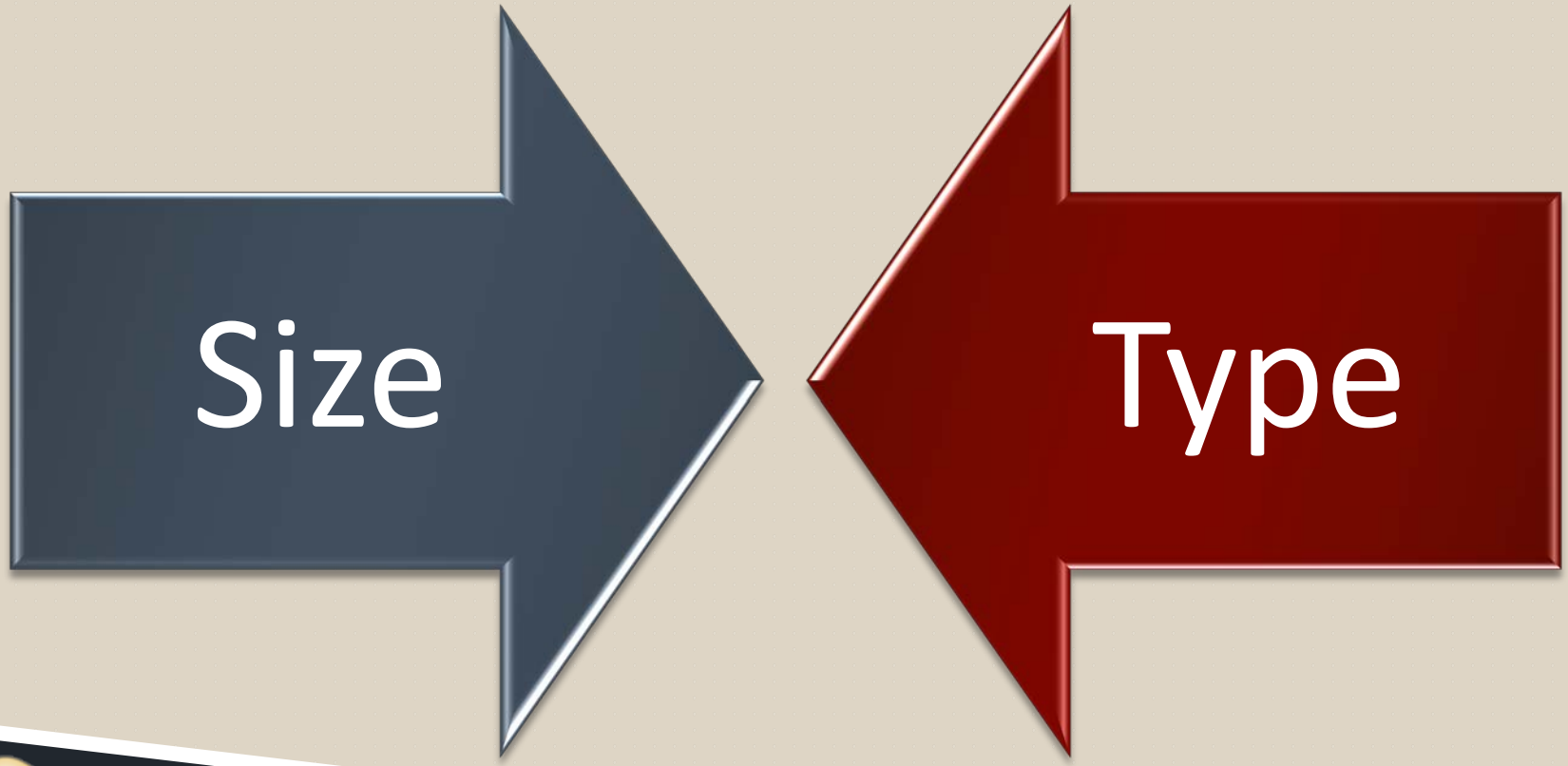
FIREFIGHTERS SHOULD KNOW THAT FIRE STREAMS ARE DESCRIBED IN SEVERAL WAYS.



THE TYPE OF NOZZLE USED ON A HOSE WILL HAVE AN EFFECT ON THE FIRE STREAM.

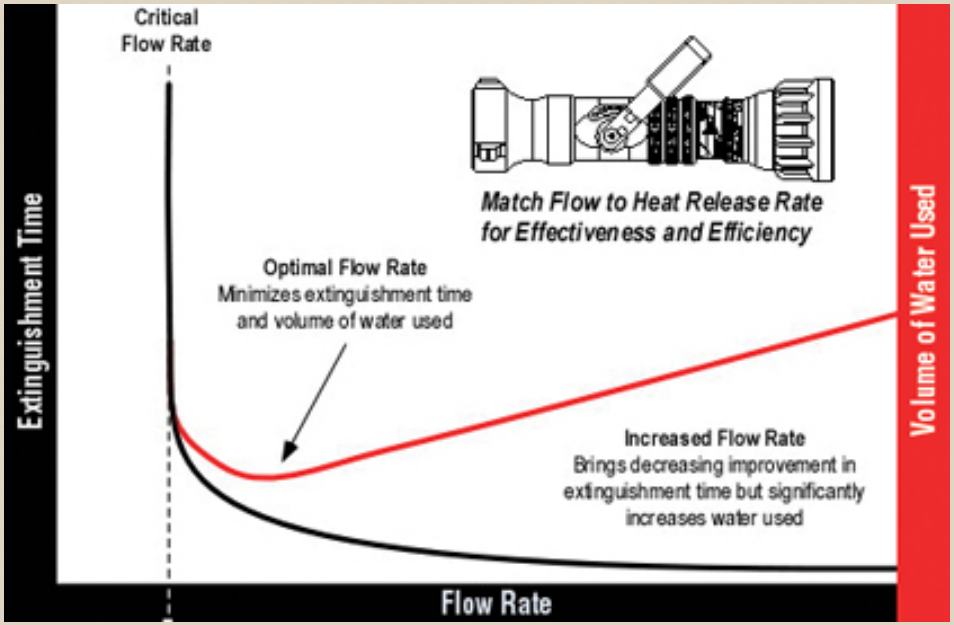
Size of opening and nozzle pressure	• Determines quantity of flow
Size of opening	• Influences reach or distance
Type of nozzle	• Determines shape

FIRE STREAM PATTERNS ARE DEFINED BY TWO CHARACTERISTICS.



FIRE STREAM SIZE IS THE RATE OF DISCHARGE, MEASURED ON A PER MINUTE BASIS.

THE VOLUME OF WATER DISCHARGED IS DETERMINED BY NOZZLE DESIGN AND WATER PRESSURE.



FIRE STREAM TYPE IS THE PATTERN OR SHAPE OF THE STREAM AS IT LEAVES THE NOZZLE.

Pattern

- Must be compact enough for majority to reach burning material
- Must meet, exceed critical flow rate
- Must have sufficient reach to put water where needed
- Types may be any size classification

SEVERAL COMPONENTS ARE REQUIRED FOR A FIRE STREAM TO BE EFFECTIVE.

A SOLID STREAM IS PRODUCED FROM A FIXED ORIFICE AND A SMOOTH BORE NOZZLE.

Courtesy of Major Danny Atchley, Oklahoma City (OK) Fire Department

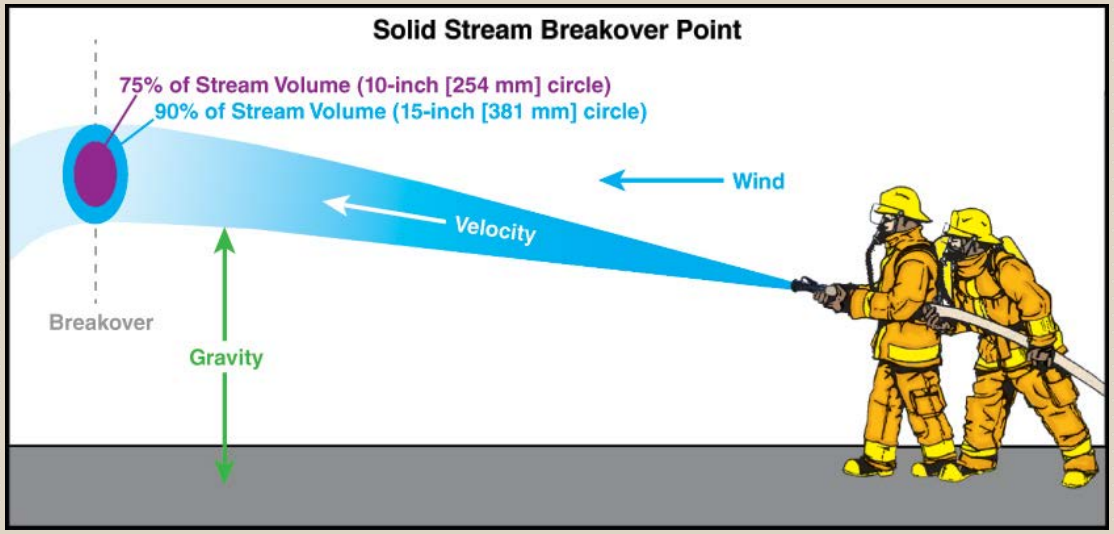
SOLID STREAM CHARACTERISTICS CAN BE DESCRIBED BY SEVERAL CONCEPTS.

- Good reach and stream penetration
- Stream produced at low nozzle pressure
- Produces less steam conversion
- Provides less heat absorption per gallon (liter)
- More likely to conduct electricity

CAUTION

Do not use solid streams on energized electrical equipment.

SOLID STREAM RANGE AND PERFORMANCE ARE BASED ON SPECIFIC CHARACTERISTICS.



Cohesive in gentle breeze

Correct velocity

FOG STREAM COMPOSITION ALLOWS IT TO ACHIEVE DESIRED PERFORMANCE.

Composition

- Water droplets, different patterns
- Expose maximum surface area

Performance

- Amount of heat absorbed
- Rate water converts to steam

FOG STREAM CHARACTERISTICS ARE DESCRIBED BY SEVERAL CONCEPTS.

- Patterns adjust
- Several uses
- Reduce heat through water surface exposure
- Can cool hot gas layer, hot surfaces
- Shorter reach, penetration than solid or straight
- More affected by wind

Characteristics

If applied incorrectly

- Disturb thermal layering
- Intensify fire by pushing fresh air into fire area

FOG STREAM ANGLE AND MAXIMUM REACH ARE ALSO CONCEPTS YOU MUST UNDERSTAND.

Patterns

- Narrow-angle
- Wide-angle

Maximum reach

- 100 psi (700 kPa) standard nozzle pressure
- Once at maximum pressure, increasing will not increase reach

THE STRAIGHT STREAM IS PRODUCED BY USING A FOG NOZZLE.

Rotate shaper

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Similar to solid stream characteristics

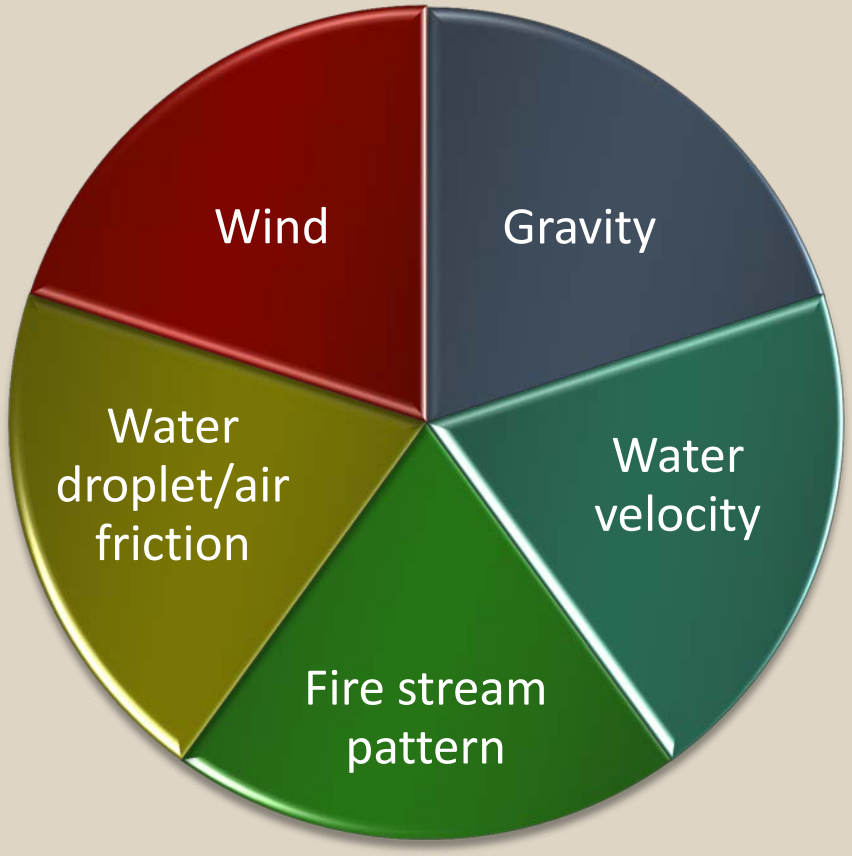
A BROKEN STREAM IS CREATED AND DESCRIBE IN SEVERAL DIFFERENT WAYS.

- Specialized nozzles
- Takes on form leaving device
- Producing effects
- Various uses for extinguishment

CHARACTERISTICS OF BROKEN STREAMS ARE DESCRIBED IN SEVERAL WAYS.

- Coarse droplets absorb more heat per gallon (liter) than solid stream
- Greater reach and penetration than fog stream
- Can be effective on fires in confined spaces
- May have sufficient continuity to conduct electricity
- Stream may not reach some fires

YOU SHOULD KNOW THE FACTORS THAT WILL AFFECT THE REACH OF A FIRE STREAM.



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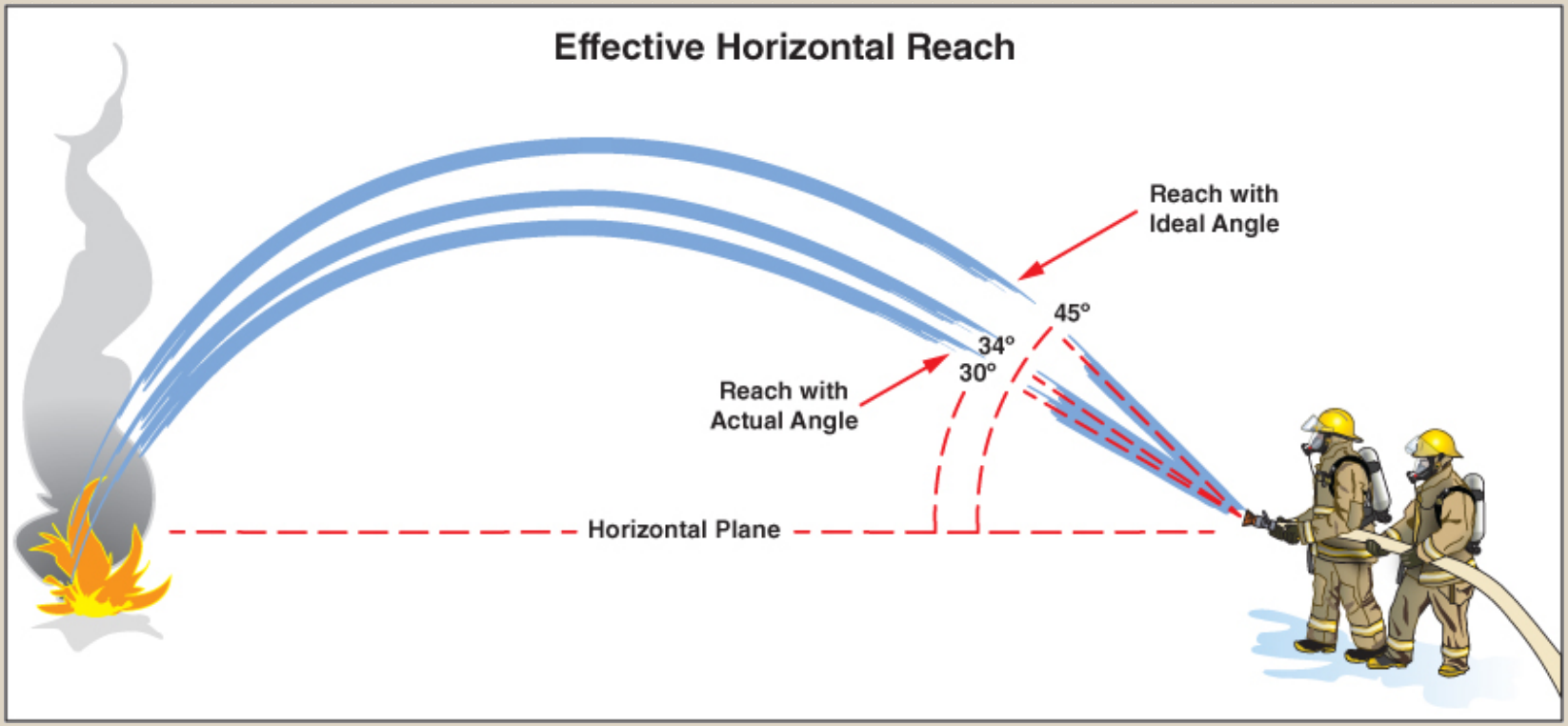


FIRE STREAM NOZZLES FALL INTO DIFFERENT CATEGORIES BUT HAVE THE SAME FUNCTIONS.

NFPA® 1963

- Straight tip (Smooth bore)
- Spray (Fog)

+

Not in standard

- Broken-stream devices

→

Functions of both

- Control water flow
- Create reach
- Shape fire stream

THE DESIGN OF SMOOTH BORE NOZZLES REDUCE THE SHAPE OF WATER IN THE NOZZLE.

Courtesy Elkhart Brass Manufacturing Company, Inc.

Courtesy of Task Force Tips

Courtesy of Akron Brass Company

SMOOTH BORE NOZZLES HAVE SEVERAL CHARACTERISTICS YOU SHOULD KNOW.

- Operate at low nozzle pressures
- Less prone to clogging with debris
- Used to apply compressed-air foam
- May allow hoselines to kink
- Do not allow for selection of different stream patterns

THE FLOW RATE OF SMOOTH BORE NOZZLES DEPENDS ON TWO CONCEPTS.

Velocity of stream

- Result of nozzle pressure
- Tips may be equipped for flow rate

Size of nozzle

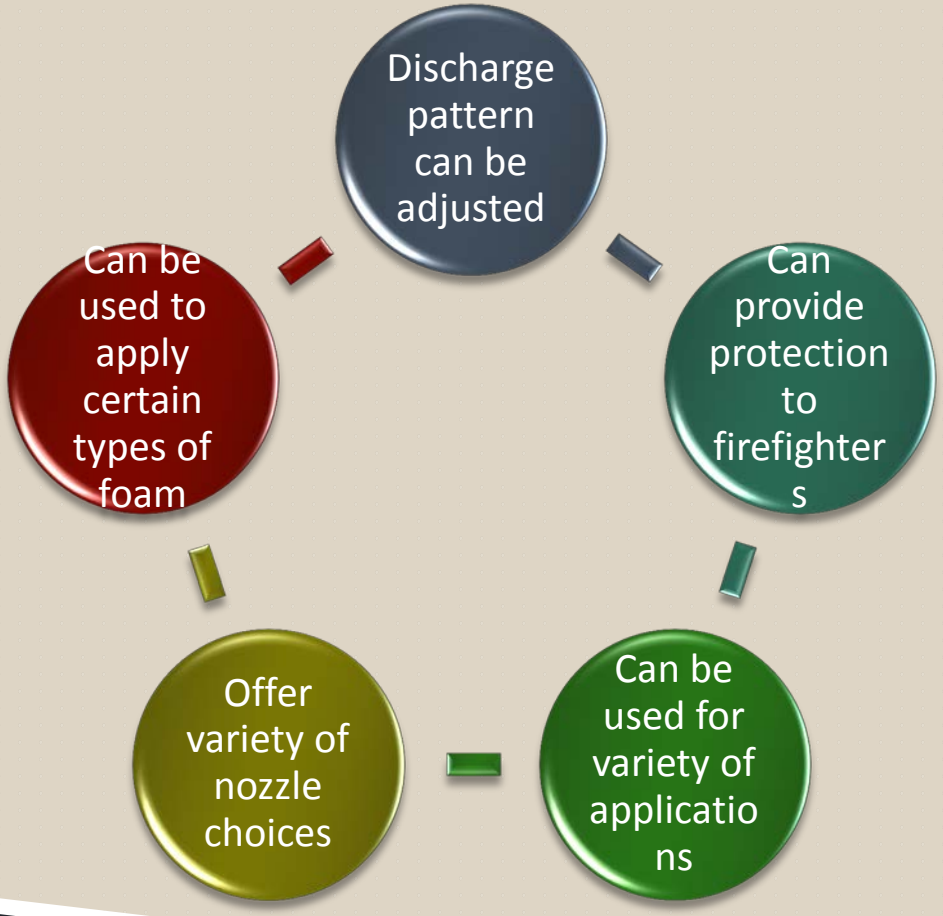
FOG NOZZLE OPERATION CAN CREATE SEVERAL PATTERNS USING SPECIFIC PRESSURE.

Patterns

- Straight stream
- Narrow-angle fog
- Wide-angle fog

Should be operated at designed pressures

THE CHARACTERISTICS OF FOG NOZZLES FALL INTO SEVERAL CATEGORIES.



THERE ARE SEVERAL TYPES OF FOG NOZZLES TO USE ON THE FIREGROUND.

Courtesy of Shad Cooper, Wyoming State Fire Marshal's Office

Basic

Constant gallonage

Constant pressure (automatic)

Constant/ select gallonage

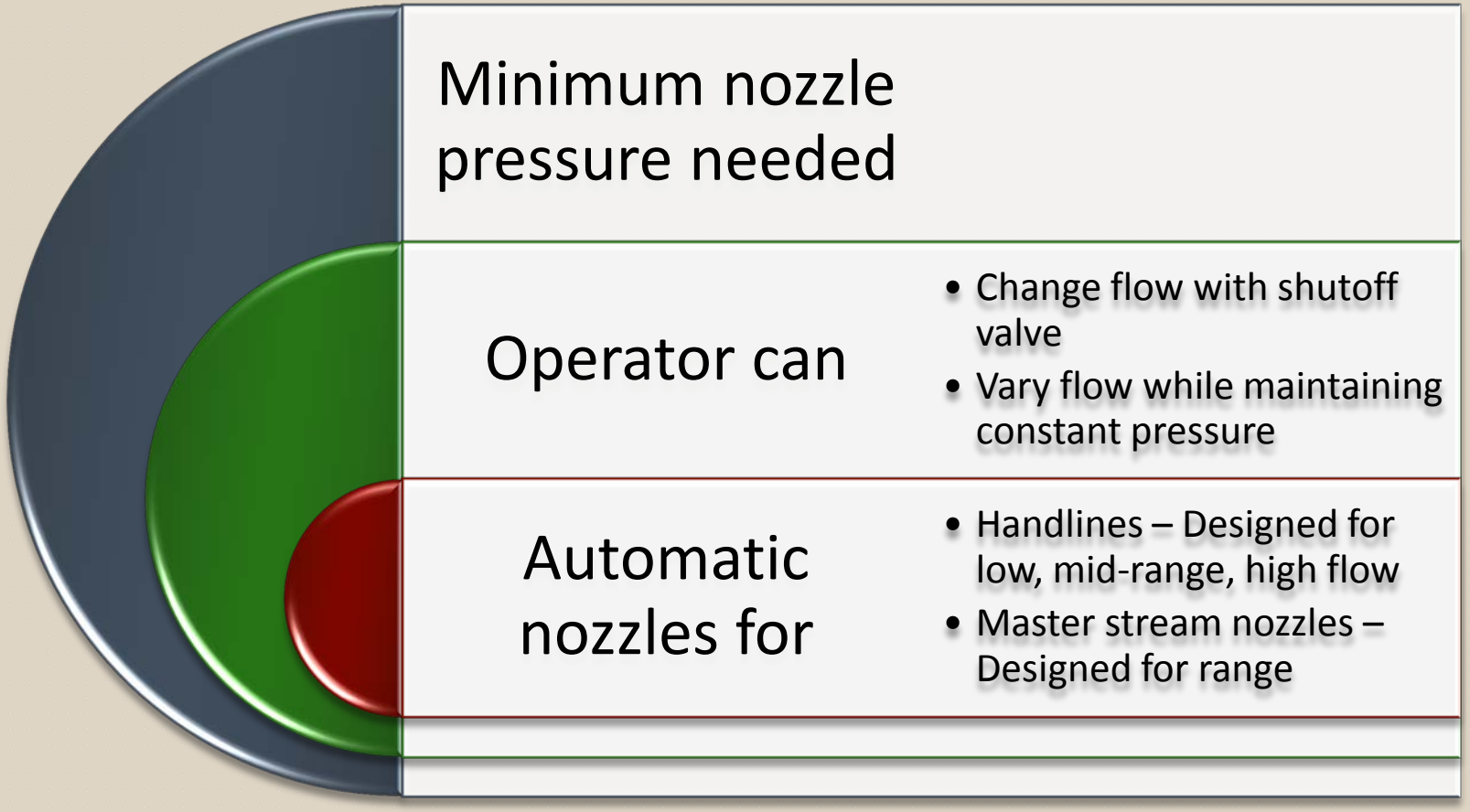
MANUALLY ADJUSTABLE FOG NOZZLES CAN ALLOW RATE OF DISCHARGE CHANGES.

- Located behind nozzle tip
- Flow constant as long as pressure present
- Operator can make choice
  - Before opening
  - While flowing
- Rates depend on nozzle size
- May have flush setting
- Make adjustments in small increments

CAUTION

Abrupt changes in the reaction force of the hoseline may throw firefighters off balance.

CONSTANT-PRESSURE FOG NOZZLES AUTOMATICALLY VARY FLOW RATE TO MAINTAIN CONSTANT PRESSURE.



FOG NOZZLES ARE DESIGNED TO OPERATE AT A VARIETY OF NOZZLE PRESSURES.

Most – 100 psi (700 kPa)

75, 50, 45 psi (525, 350, 315 kPa) also available

BROKEN STREAM DELIVERY DEVICES CAN BE USED FOR CONCEALED SPACE FIRES.

Courtesy of Shad Cooper, Wyoming State Fire Marshal's Office

Piercing nozzles

Bresnan distributors

Rockwood cellar pipe

NOZZLE CONTROL VALVES ALLOW THE OPERATOR TO ACCOMPLISH SEVERAL TASKS.

Influence flow of water

- Start, stop
- Increase, decrease

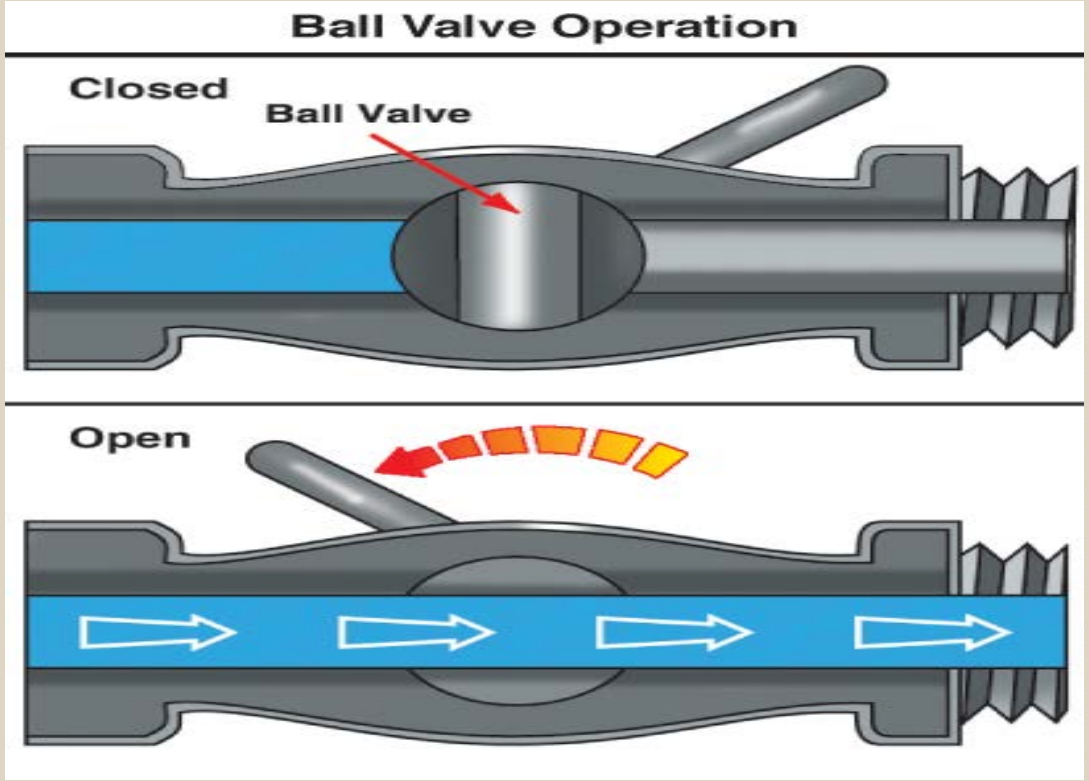
Open nozzle slowly

Control nozzle reaction increases

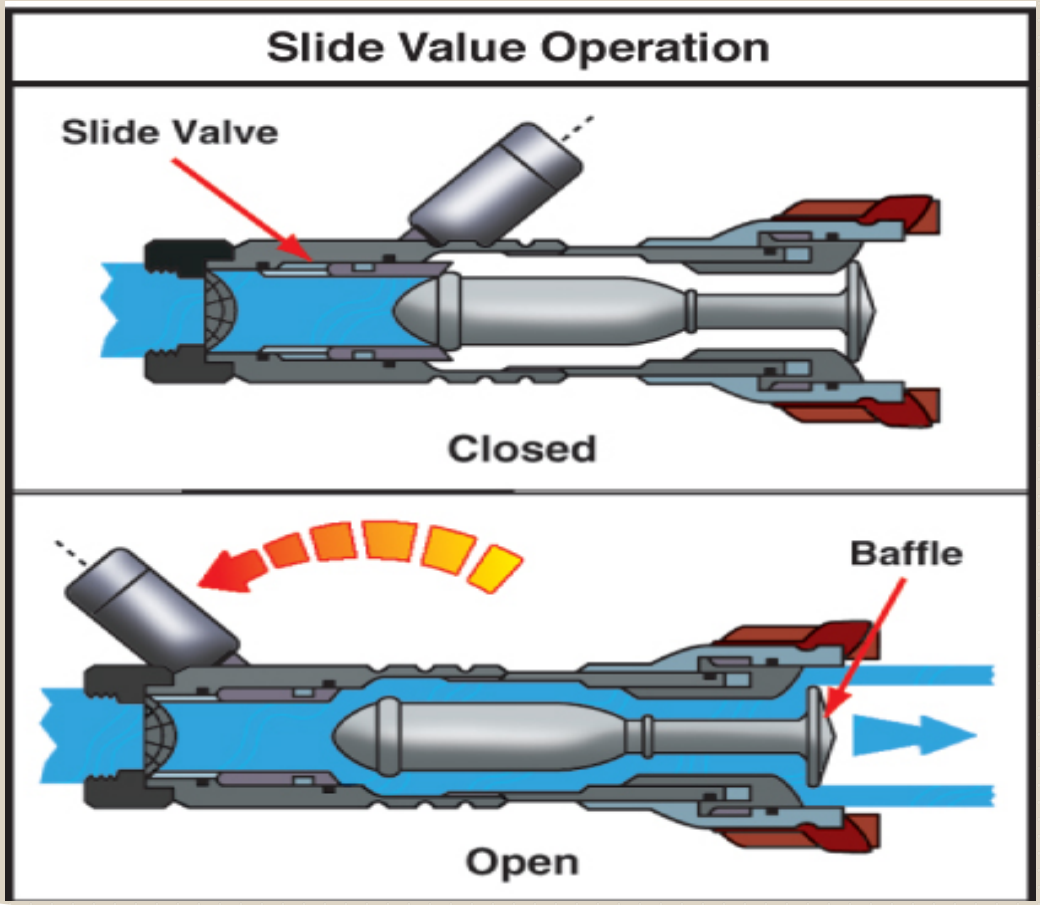
Close slowly

- Prevent water hammer

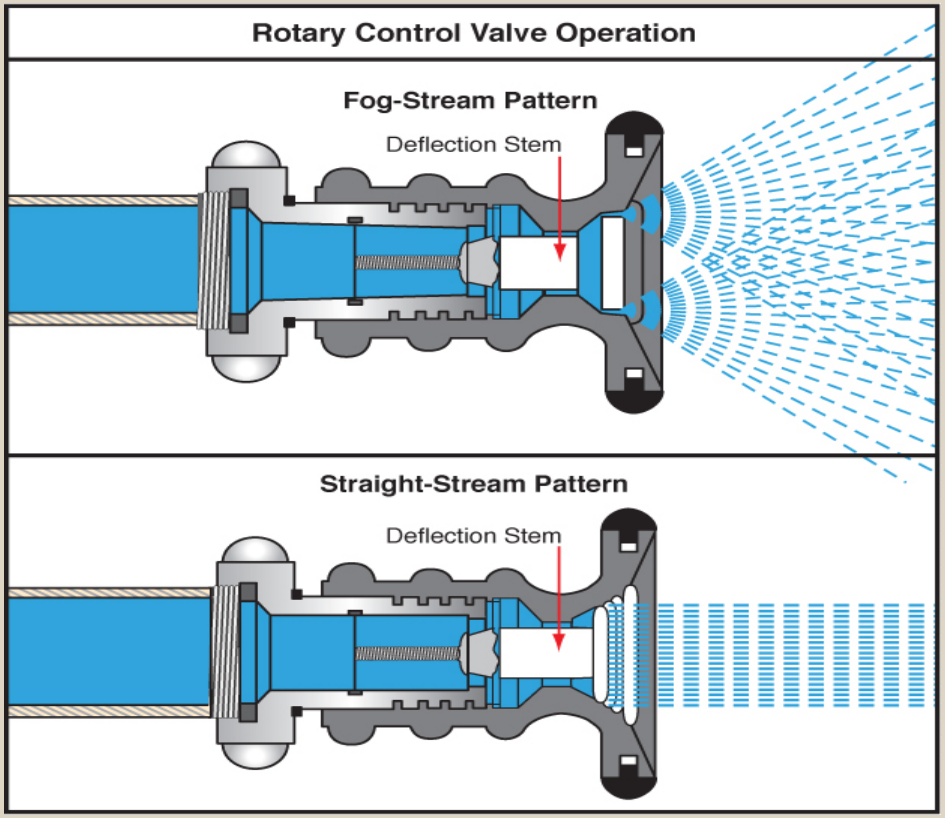
THE BALL VALVE IS THE MOST COMMON TYPE OF NOZZLE CONTROL VALVE.



THE SLIDE VALVE USES A MOVEABLE CYLINDER TO TURN OFF WATER FLOW.



THE ROTARY CONTROL VALVE IS ONLY FOUND ON ROTARY CONTROL FOG NOZZLES.



OPERATING SMOOTH BORE NOZZLES REQUIRES UNDERSTANDING THE FORCE THEY CREATE.

Water flow creates force in direction of stream

Equal force in opposite direction

- Pushes back on operator
- Caused by
- Makes nozzle difficult to handle

SMOOTH BORE NOZZLES ARE CONTROLLED BY USING SPECIFIC STEPS.

Cradle hoseline in one arm and hold nozzle, pistol grip in one hand

Pull slowly back on bale with other hand, open nozzle

As action increases -

- Lean forward with both legs apart, one foot forward, weight distributed evenly on both feet
- Interior operation – Operate in similar fashion, kneeling on one knee

Personnel required

- One person – 1½ inch (38 mm) or smaller
- Additional – 1¾ inch (44 mm)

FOG NOZZLE OPERATION WILL VARY DEPENDING ON THE SETTING USED.

Pattern

- Straight-stream, narrow-stream similar to smooth bore
- Wider pattern – Reaction decreases

Handle same as smooth bore

NOZZLE INSPECTION IS PERFORMED AFTER EVERY USE OR AT LEAST ANNUALLY.

Maintenance, care, cleaning

Technical maintenance

NOZZLE INSPECTION ACTIONS CAN BE THE SAME NO MATTER WHAT TYPE OF NOZZLE.

- Inspect swivel gasket
- Look for external damage
- Look for internal damage, debris
- Check for ease of operation
- Ensure pistol grip secured to nozzle
- Ensure all parts in place, good condition

THERE ARE SEVERAL STEPS TO FOLLOW FOR GENERAL NOZZLE CARE.

- Thoroughly clean after each use
- Follow manufacturer's recommendations to clean, lubricate moving parts
- Store with valve control bale in closed position
- Never drop or drag nozzle
- Use flush setting on fog nozzle, remove internal debris

SUMMARY

Firefighters must know the extinguishing properties of water, and the properties of the nozzles available in their departments.

They must understand the factors affecting fire streams.

They must know how to select, operate, and maintain the nozzles available in their department.