Essentials of Fire Fighting

6th Edition

Firefighter I

Chapter 16 — Fire Streams

Fire Streams

Learning Objective 1

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

16–2

DISCUSSION QUESTION

Why is water an extinguishing agent that is commonly used by the fire service?

16–3

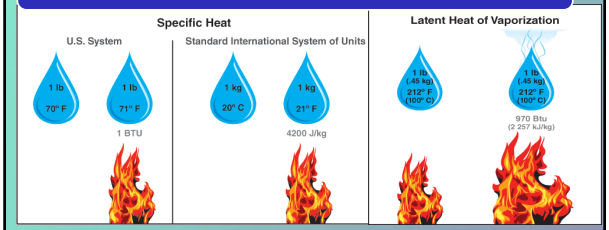
Water has several characteristics that make it valuable for extinguishment.

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

16–4

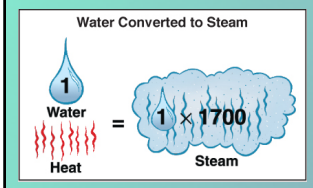
Vaporization occurs when water that is heated to boiling point converts to vapor or steam.

Energy required to change state of water



16–5

Firefighters need to understand the basic properties of steam.



Complete vaporization requires boiling temperatures be maintained

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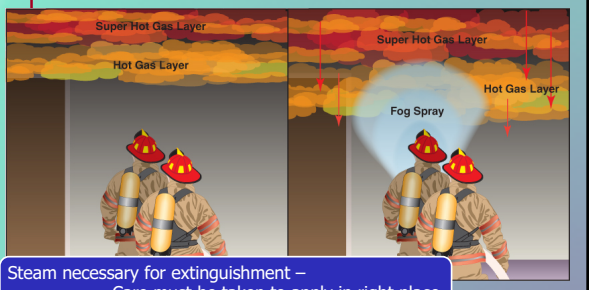
16–6

Firefighters need to understand the basic properties of steam.



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

16–7

REVIEW QUESTION

What are the extinguishing properties of water?

16–8

Learning Objective 2

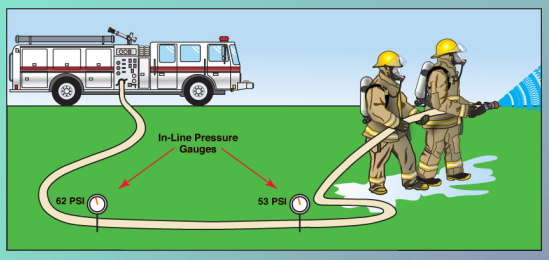
Identify the factors that create pressure loss or gain.

16–9

Its not always high pressure around here, but when it is...

11–10

The principles of friction loss will impact water pressure on scene.



16–11

Other on scene components will impact friction loss.

- Practical limits to velocity of water in hoseline
- Hose size, length of hose lay
- Rough linings in fire hose
- Number of adapters
- Sharp bends in hose
- Damaged hose couplings
- Length of hose lay
- Hose diameter

16–12

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

16–13

The difference in elevation between the nozzle and pumping apparatus causes elevation pressure.

Courtesy of Bob Esposito

16–14

REVIEW QUESTION

How can friction loss and elevation loss/gain impact fire stream pressure?

16–15

Learning Objective 3

Describe the impact water hammer has on fire streams.

16–16

Water hammer is pressure created when the nozzle is closed suddenly.

Shock wave produced	Creates excessive pressures	Flow rates	To prevent – Close slowly
• Pressure surge results	• Can cause damage	• Minimal at low flow • Higher rates increase	• Nozzles • Hydrants • Control valves • Hose clamps

16–17

REVIEW QUESTION

What impact does water hammer have on fire streams?

16–18

Learning Objective 4

Explain fire stream patterns and their possible limiting factors.

16–19

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

16–20

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

16–21

Firefighters should know that fire streams are described in several ways.

- Patterns formed
- Nozzles that create patterns
- Types of control valves
- Factors that limit stream

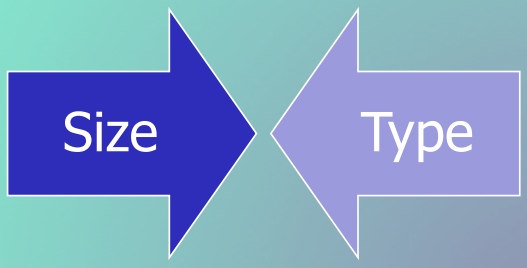
16–23

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

16–24

Fire stream patterns are defined by two characteristics.

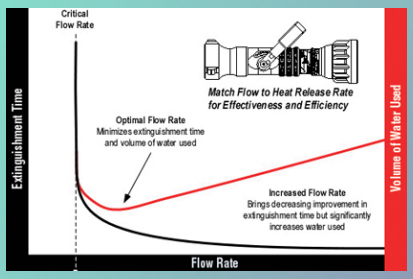


16–25

Fire stream size is the rate of discharge, measured on a per minute basis.

16–26

The volume of water discharged is determined by nozzle design and water pressure.



16–27

Fire stream type is the pattern or shape of the stream as it leaves the nozzle.

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

16–28

Several components are required for a fire stream to be effective.

16–29

A solid stream is produced from a fixed orifice and a smooth bore nozzle.

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

16–30

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

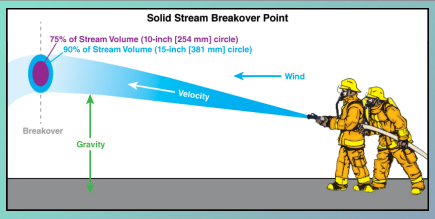
16–31

CAUTION

Do not use solid streams on energized electrical equipment.

16–32

Solid stream range and performance are based on specific characteristics.



- Cohesive in gentle breeze
- Correct velocity

16–33

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

16–34

Fog stream characteristics are described by several concepts.

- **Characteristics**
  - 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
- **If applied incorrectly**
  - Disturb thermal layering
  - Intensify fire by pushing fresh air into fire area

16–35

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

16–36

The straight stream is produced by using a fog nozzle.

- Rotate shaper
- Similar to solid stream characteristics

16–37

11–38

A broken stream is created and describe in several different ways.

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

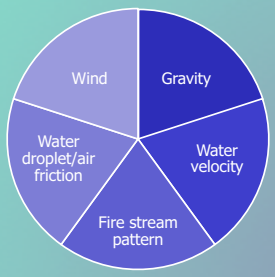
16–39

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

16–40

You should know the factors that will affect the reach of a fire stream.



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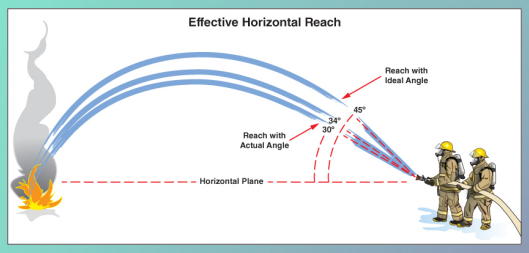
16–41

You should know the factors that will affect the reach of a fire stream.



16–42

REVIEW QUESTION

How do the four types of fire stream patterns compare with one another?

16–43

Learning Objective 5

Describe the three types of fire stream nozzles.

16–44

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

16–45

DISCUSSION QUESTION

What terms have you heard that refer to various types of nozzles?

16–46

The design of smooth bore nozzles reduce the shape of water in the nozzle.

Courtesy of Elkhart Brass Manufacturing Company, Inc.

Courtesy of Task Force Tips

Courtesy of Akron Brass Company

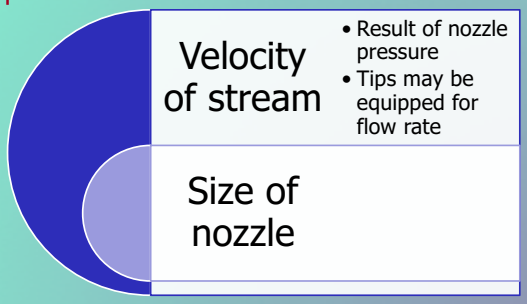
16–47

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

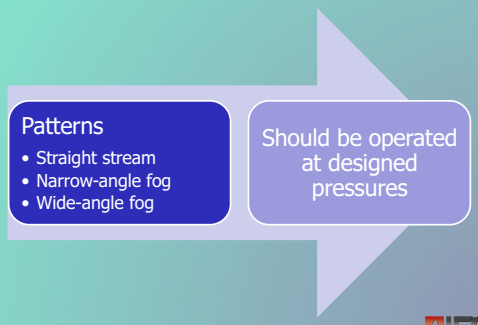
16–48

The flow rate of smooth bore nozzles depends on two concepts.



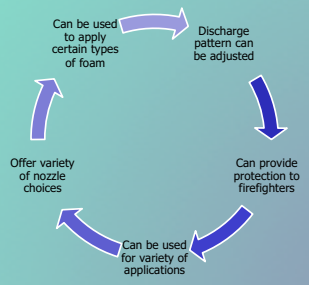
16–49

Fog nozzle operation can create several patterns using specific pressure.



16–50

The characteristics of fog nozzles fall into several categories.



16–51

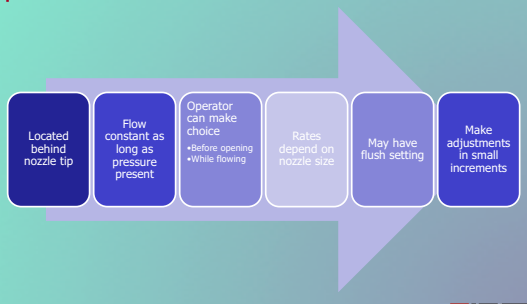
There are several types of fog nozzles to use on the fireground.

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

Basic	Constant gallonage	Constant pressure (automatic)	Constant/ select gallonage

16–52

Manually adjustable fog nozzles can allow rate of discharge changes.



16–53

CAUTION

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

16–54

16–55

Constant-pressure fog nozzles automatically vary flow rate to maintain constant pressure.

Minimum nozzle pressure needed	
Operator can	• Change flow with shutoff valve • Vary flow while maintaining constant pressure
Automatic nozzles for	• Handlines – Designed for low, mid-range, high flow • Master stream nozzles – Designed for range

16–56

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

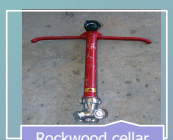
16–57

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

16–58

REVIEW QUESTION

What are the benefits of each of the types of fire stream nozzles?

16–59

Learning Objective 6

Compare the different types of nozzle control valves.

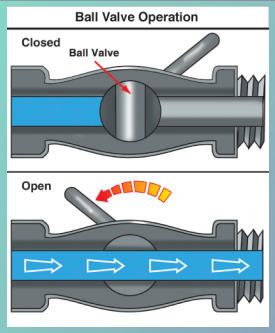
16–60

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

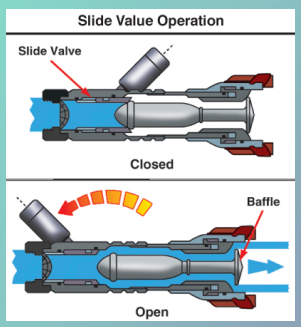
16–61

The ball valve is the most common type of nozzle control valve.



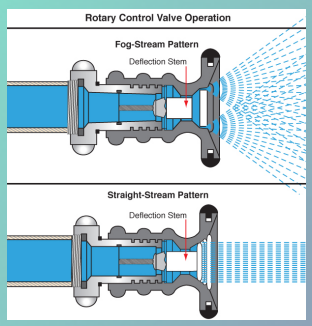
16–62

The slide valve uses a moveable cylinder to turn off water flow.



16–63

The rotary control valve is only found on rotary control fog nozzles.



16–64

REVIEW QUESTION

How do the different types of nozzle control valves compare with one another?

16–65

Learning Objective 7

Describe the factors in operating and maintaining handline nozzles.

16–66

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

16–67

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)

16–68

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

16–69

Nozzle inspection is performed after every use or at least annually.

Maintenance, care, cleaning

Technical maintenance

16–70

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

16–71

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

16–72

REVIEW QUESTION

What are the main factors to consider when operating and maintaining a handline nozzle?

16–73

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.

16–74

Learning Objective 8

Operate a fog-stream nozzle.

This objective is measured in Skill Sheet 16-I-1.

16–75

Learning Objective 9

Operate a broken-stream nozzle.

This objective is measured in Skill Sheet 16-I-2.

16–76

Learning Objective 10

Operate a solid stream nozzle.

This objective is measured in Skill Sheet 16-I-3.

16–77