
Command Competence
CFBT-US, LLC
Water Application for Fire Control
1824-Present
La Hermandad de Bomberos ONG – 25 April 2026
CFBT-LHB
Sentirse Parte de esta Gran Familia
LA HERMANDAD DE BOMBEROS
de Primeros Respondientes

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Chief Ed Hartin, MS, EFO, FIFireE, CFO
Chief Francis J. Hartin
1917-2008
Learning the Craft Since ~~1974~~ 1954

2


CONCORD
17 75
FIRE
23 April 1974
FIRE SAFETY RESEARCH INSTITUTE
UL
28 February 2025
EAST COUNTY FIRE AND RESCUE
EST 2006

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Fire is both a powerful and insidious enemy, and those whose business it is to attack it, will best succeed when they have become skillful and experienced in the use of their arms.

It is quite obvious that an establishment of this sort [fire brigade], however complete in its apparatus and equipment, must depend for its efficiency on the state of training and discipline of the firemen

On the Construction of Fire Engines and Apparatus, the Training of Firemen, and the Method of Proceeding in Cases of Fire , 1830
James Braidwood
Master [Fire Chief] of the Edinburg Fire Engine Establishment

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In order to carry on your business properly, *it is necessary for those who practice it to understand not only what they have to do, but why they have to do it…*

No fireman can ever be considered to have attained a real proficiency in his business until he has thoroughly mastered this *combination of theory and practice*.

Fire Protection, *1876*
Sir Eyre Massey Shaw
Chief, London Fire Brigade

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In principle, firefighting is very simple. All one needs to do is put the right amount of water in the right place and the fire is controlled.
Floyd W. Nelson, *Qualitative Fire Behavior*

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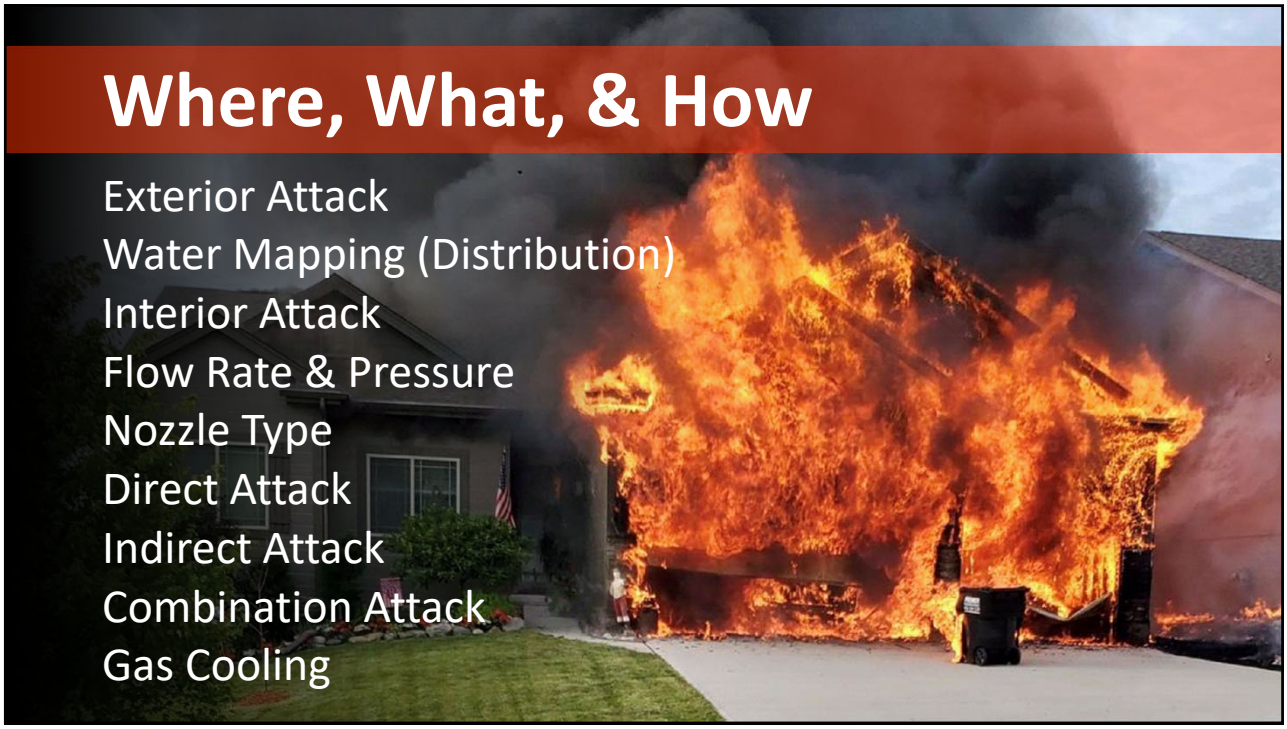
Where, What, & How
Exterior Attack
Water Mapping (Distribution)
Interior Attack
Flow Rate & Pressure
Nozzle Type
Direct Attack
Indirect Attack
Combination Attack
Gas Cooling

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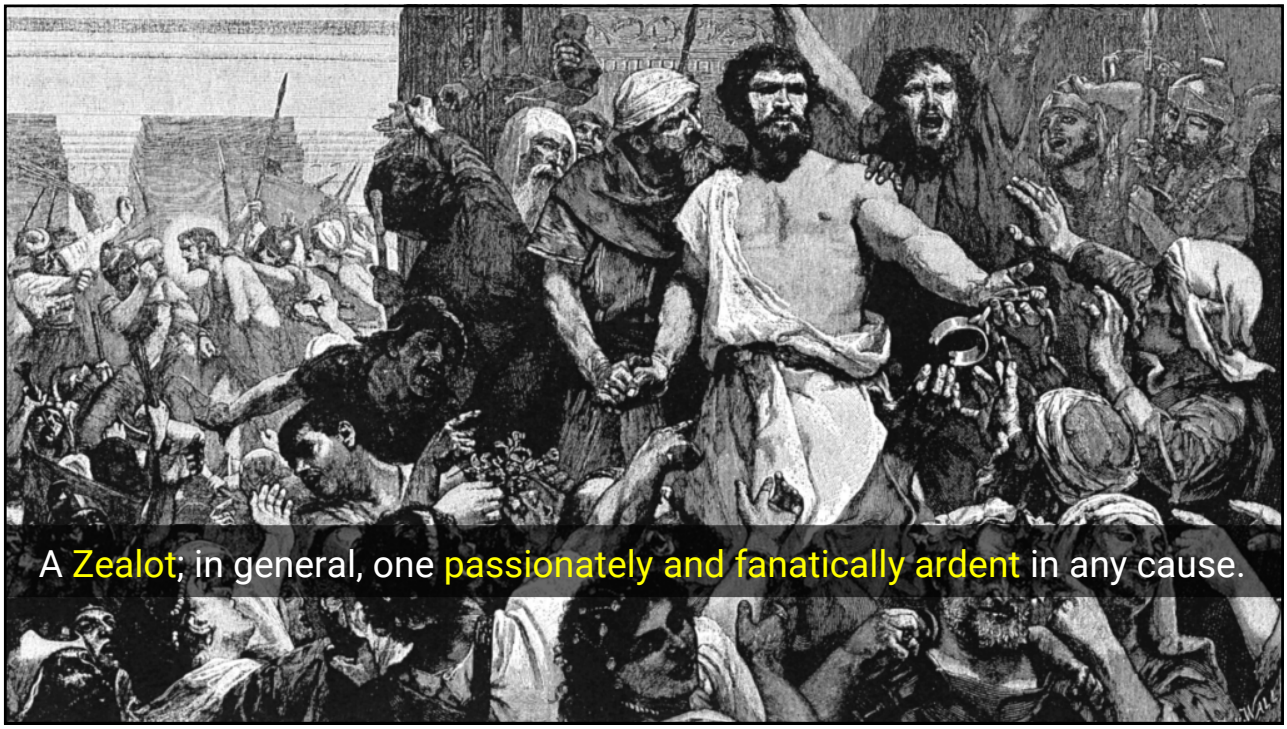
A Zealot; in general, one passionately and fanatically ardent in any cause.

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Firefighting Context
EDINBURGH
~1824~

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James Braidwood

1800-1861

Quick and effective water application in a direct attack

- Exterior application
- Interior application

Limit air flow to the fire

Speed is of the essence

https://www.london-fire.gov.uk/museum/history-and-stories/the-tooley-street-fire/

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Eyre Massey Shaw

1828-1908

Experience is necessary, but not sufficient

Ventilation and anti-ventilation

Factors that influence fire stream performance

Coordinated fire attack

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John Kenlon

1861-1940

In many respects fires behave in a predictable manner

Scientific training is necessary

Regrowth during strategic shift

Backup lines are important

Decisions must be made in a timely manner

Context is critical

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Fire Chief's Handbook

Fred Shepperd, Editor

Scientific concepts related to chemistry & physics of fire

Importance of water distribution and water mapping for interior and exterior streams

The amount of water needed is smaller if distributed on the burning fuel and ineffective water distribution can result in significant water damage

Nozzle discipline (not simply to hold your water)

Well advanced basement fires should be attacked before entry

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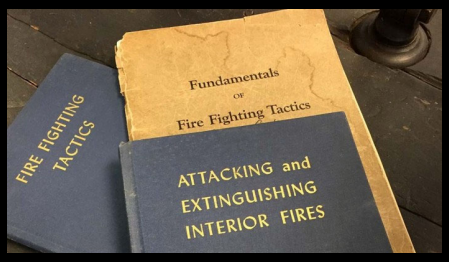
Lloyd Layman

1897-1968

[Maximum vaporization] cannot be obtained by applying water in the form of a solid stream… Little if any progress can be made in improving the tactical employment of water in fire fighting operations until the gross ineffectiveness of the solid stream method of application is recognized.



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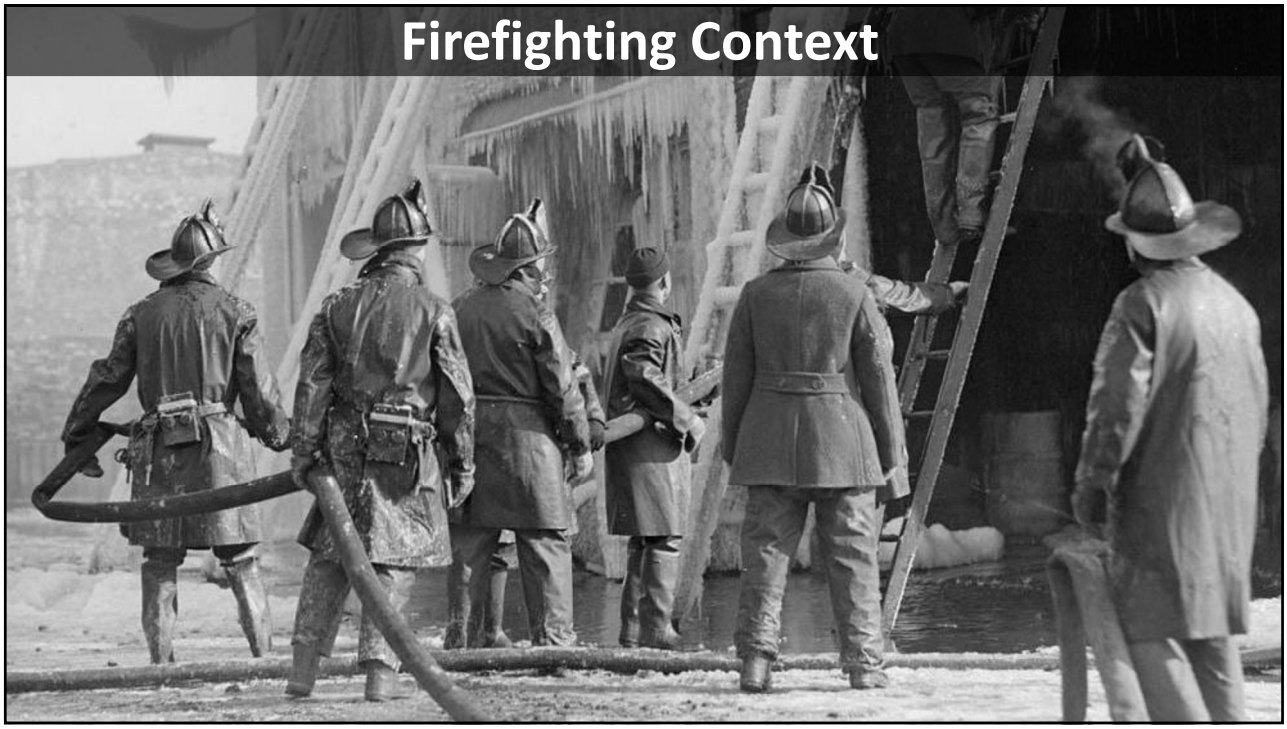
Firefighting Context



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Indirect Attack

- Limitation of ventilation before fire control
- Application of water fog in the upper area
- Absorption of thermal energy from hot gases and surfaces
- Mixing due to convection
- Increased pressure due to steam expansion
- Continued cooling and contraction of steam
- Timely direct attack is required to complete extinguishment

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Royer & Nelson

Iowa Sate University
Fire Service Training

The combination attack integrates both direct and indirect methods using a fog pattern adjusted to reach across the entire area, rotating the nozzle in a clockwise ‘O’ pattern.

Developed the Iowa Fire Flow Formula – How much water is enough?

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Rosander & Giselsson

Swedish Fire Service

Gas cooling in the Swedish model applies small droplets (<0.3 mm) to cool hot gases without vaporizing on contact with surfaces. Cooling the gases results in contraction (to a greater extent than expansion of the water vaporized into steam). *More on this later!*

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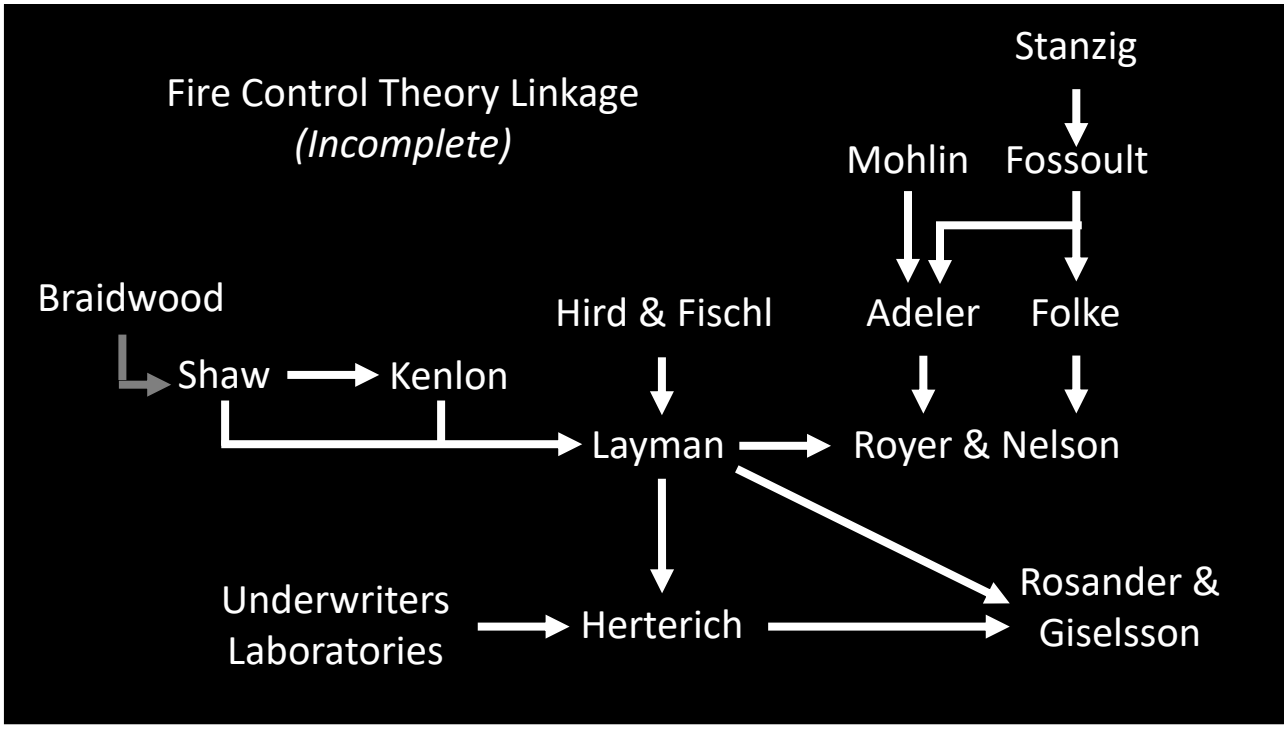

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Cooling Gases

- Small droplets are effective in cooling the gases
- Duration of application and cone angle depend on the size of the space

If > 35% of the water is vaporized in the upper layer, the layer will contract.

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Vaporization in the Gas Layer

- Water vaporized in the upper layer takes energy from the hot gases, lowering their temperature.
- It takes much more energy to heat and vaporize water than to cool hot gases.

Specific Heat of Smoke 0.001 MJ/kg

VS

*TCC of Water 2600 MJ/kg (2.6 MJ/kg)**

** Water at 20° C to Steam at 100° C*

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Surface Cooling

- Water may be applied to cool burning fuel, pyrolizing fuel packages or to cool uninvolved surfaces.
- Surface cooling is a critical element in fire control and extinguishment.
- The required flow rate per m^2 is quite low if the time for extinguishment is infinite

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Vaporization on Surfaces

- Water vaporized on hot surfaces does not take as much energy from hot gases (as water vaporized in the gases).
- Steam produced on surfaces will add to the hot upper layer (1700:1 at 100^{o} C) increasing thermal ballast.

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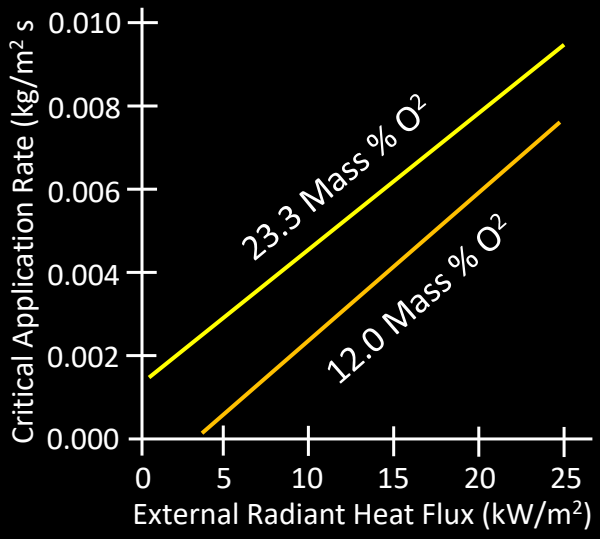
Critical Flow Influencing Factors



- Radiant Heat Flux
- Oxygen Concentration

Stefan Särdqvist
Water and Other Extinguishing Agents (p. 317)

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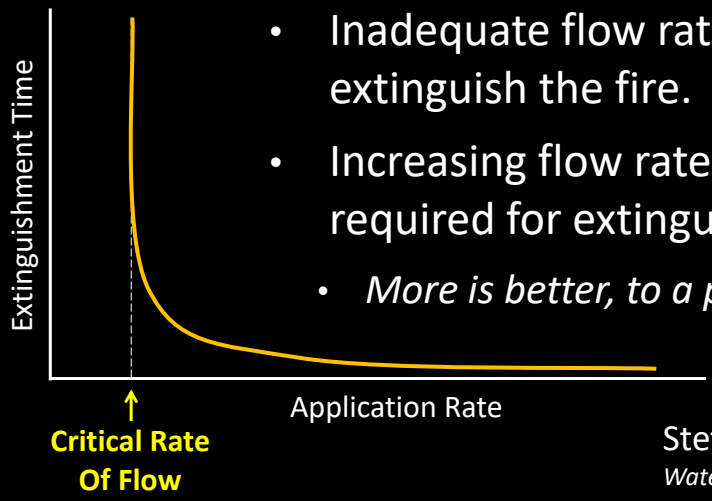
Critical Rate of Flow



- Inadequate flow rate will fail to extinguish the fire.
- Increasing flow rate reduces the time required for extinguishment.
  - *More is better, to a point…*

Stefan Särdqvist
Water and Other Extinguishing Agents (p. 21)

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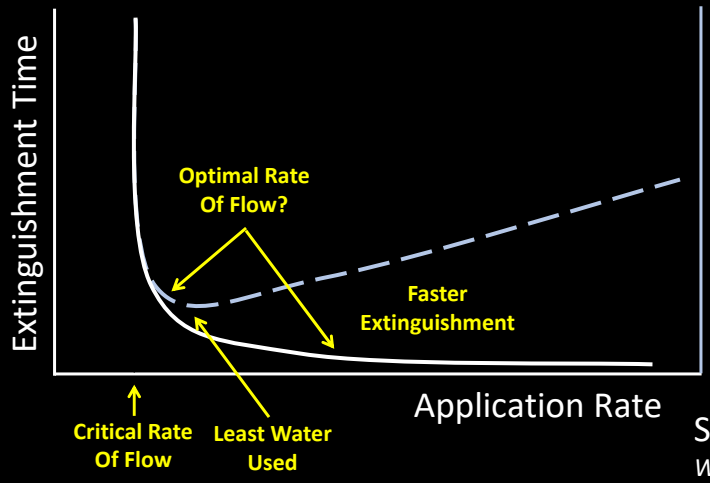
Flow, Time, & Water



- Effectiveness
- Efficiency

What's the difference?

Is this a question of one, the other, or both?

Stefan Särdqvist
Water and Other Extinguishing Agents (p. 21)

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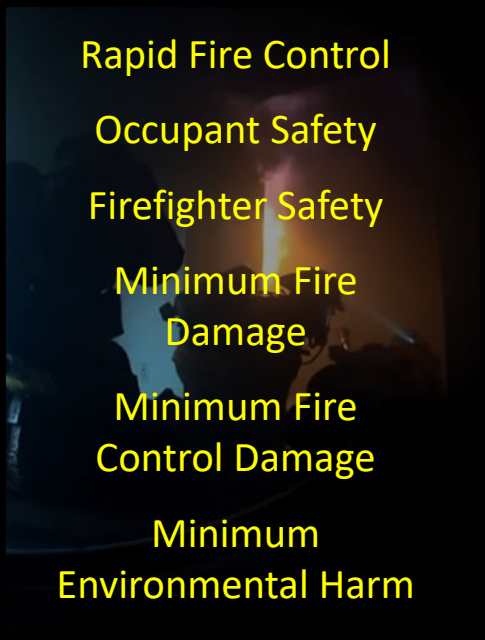
Effectiveness

- The degree to which something is successful in producing a desired result.
- When deploying and operating an attack line for fire control, what are the desired results?



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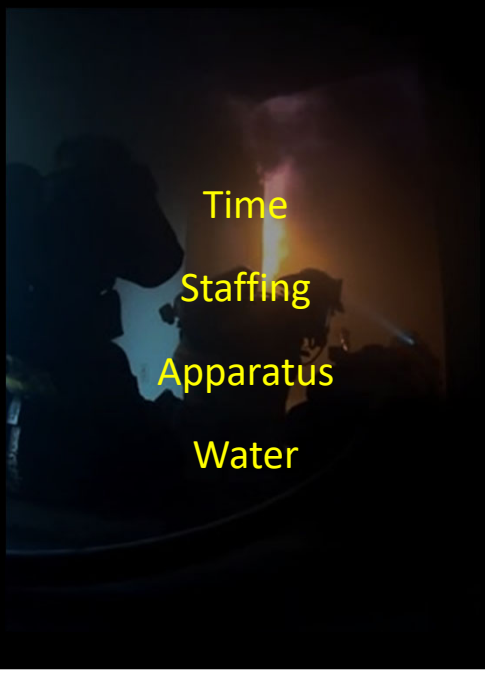
Efficiency

- A level of performance that creates the greatest output (effectiveness) with the smallest input
- When operating an attack line for fire control, what are the inputs?



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The Answer….

- Ideally an attack line will be both efficient and effective.
- An effective hoseline puts the water where it needs to be in the form that it needs to be in.
- Water may need to be applied to cool hot gases, surfaces, or both.

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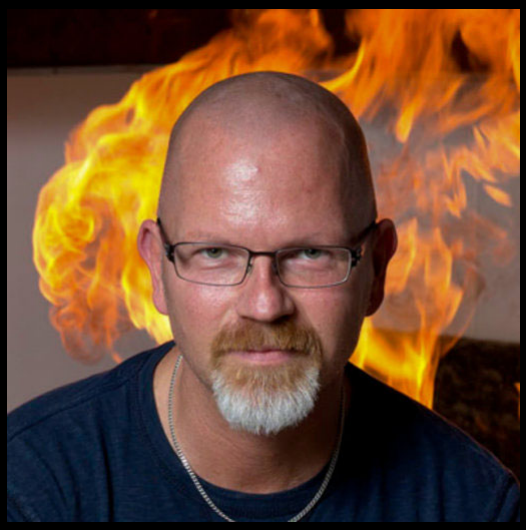

It's actually very simple: If there's fire, open the nozzle. If there's no fire, close the nozzle. If you need to cool hot gases, open the nozzle. If you don't need to cool hot gases anymore, close the nozzle. If fire is far away, use a straight stream. If fire is close [or if hot gases are close], use a wider stream.

Stefan Svensson, PhD

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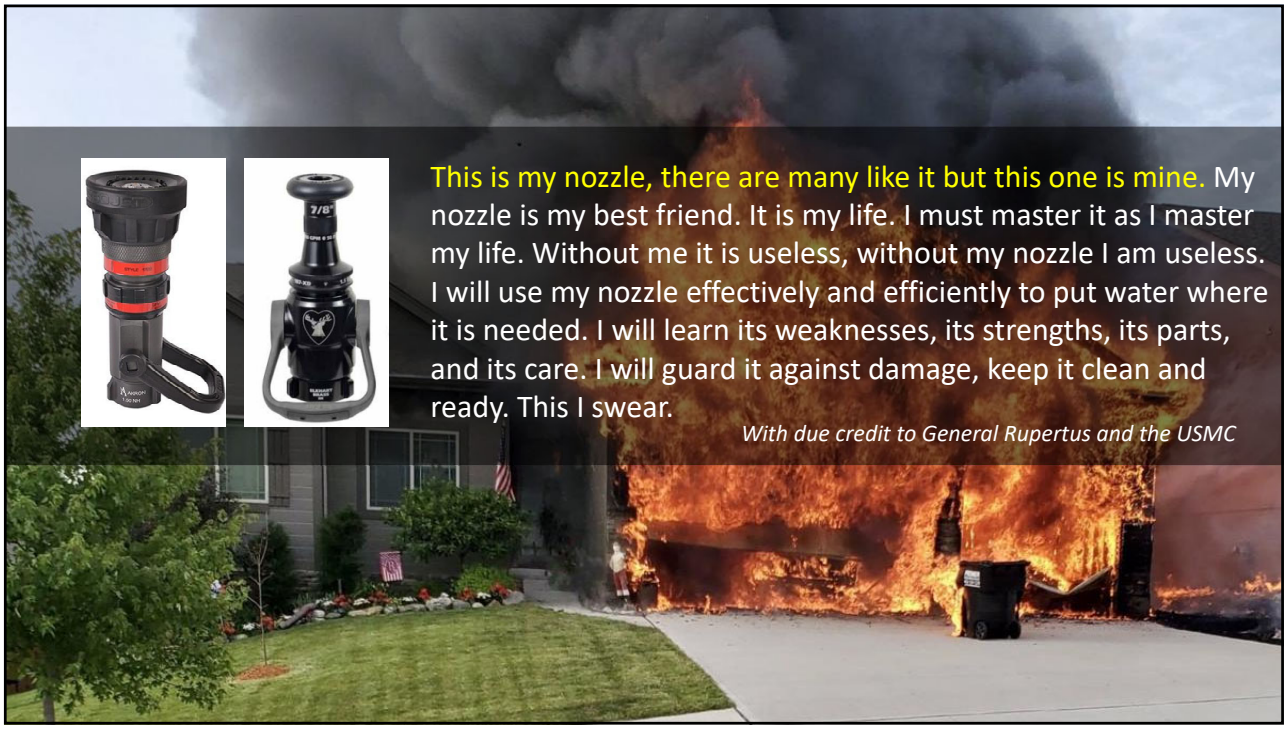

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Current Research

- Water mapping is critical.
- Water does not push fire.
- Air entrainment may matter (or not).
- Coordination of water application and ventilation is critical.
- Time may matter more than position
- Regrowth is an important consideration.

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Unified Theory of Fire Control

Beware Zealots (of any perspective)
You generally find what you look for
Firefighters are extinguishing fires all around the world
Physics is physics (and the fire does not recognize place)
Size, geometry, and configuration matter
Context is critical
Water distribution is critical and air entrainment is relevant
Hot gases and surfaces need to be cooled
Effectiveness is critical (and so is efficiency, but what does that look like?)

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Questions?

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Download the presentation (PDF)

Visit the website!

CFBT-US
Not just what and how, but why!

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