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Bushfire Sprinklers

Breaking the Water Barrier



Presented by:
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FPA AUSTRALIA BUSHFIRE SPRINKLERS: THE FUTURE

M-bar Technologies and Consulting, LLC

The Water Barrier

Enough water can prevent ignitions…

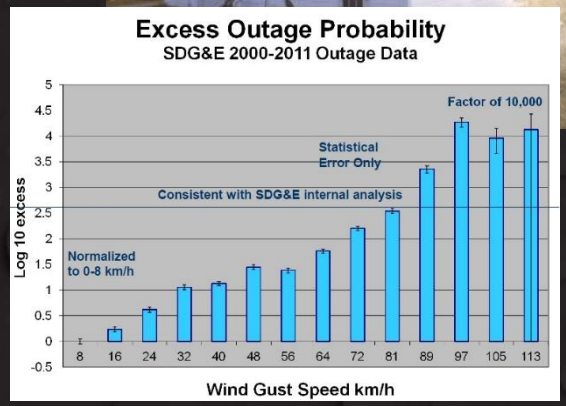
But…

How much water is necessary to prevent firebrand ignition?

My Background

Joseph W. Mitchell, Ph.D.

- Particle physics research (1981-1996)
- Wildland fire research (home ignition prevention, power line fires 2002-present)
- Expert witness at the California Public Utilities Commission on Power Line (2007-present)
- Published in Fire Safety Journal, Fire and Materials, Engineering Failure Analysis



Wind-Enabled Ember Dousing (WEEDS)

CONCEPT: Achieve wind-resilient brand protection by directing coarse water spray outward from the structure.

- The wind blows it back onto the structure
- Spray accumulates prior to embers landing
- Firebrands land in active spray field
- *Mid-air collisions not necessary*

J.W. Mitchell – Fire Safety Journal 2006

Water Spray Science and Practice, 2025

The Good,

The Bad,

and The Missing

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The GOOD, The BAD, and the MISSING

- A lot of WUI science (Filkov, et al., 2023 Fire Safety Journal 332 separate citations)
- Extensive studies of water sprays (Green)
- Manufacturers and Installers (Platypus, Embarr)
- Standard in place in Australia (AS 5414)
- Dragon firebrand test apparatus (NIST, IBHS)

The GOOD, The BAD, and the MISSING

- A limited number of private DIY installs
- Massive water needs to meet standards
- Expensive
- Not accepted practice in US
- Fatalities associated with failures (Black Saturday)
- Slow adoption

The GOOD, The BAD, and The MISSING

- There is no science of firebrand ignition under water spray.
- We don't know how wet/saturated surfaces affect brand ignition.
- There is no reliable mechanism for ensuring activation during ember attack.

Firewise principles

- Manage vegetation and other flammable material in the home ignition zone to reduce **radiant heat** and prevent **flame contact**.
- Construct and maintain structures to reduce the risk of piloted ignition from **embers** (firebrands).

Why would water spray be necessary?

Water spray justifications:

- **Redundancy:**
  - Hidden vulnerabilities
  - Maintenance oversights
- **WUI issues:**
  - Historical / vulnerable structure / code
  - Can’t control all home ignition zone
- **Security**
  - Entrapment potential
- **Convenience**

How much water do you need?

- To put out a wildfire, a lot
- To protect a home against radiant heat and flame, a lot
- Cohen et al, 2004 – 13.1 kW/m^2 threshold
- AS 3959 – 12.5 kW/m^2 (windows)
- Separation from fuels is preferable!

AS 5414 – Bushfire Water Spray Systems

- 19 kW/m^2
- Focuses water spray onto areas vulnerable to embers
- 10 l/m^2-min windows
- 5 l/m^2-min other vulnerable surfaces
- 15 X 10 X 7 m = 500 m^2 ->2500 l/min

Why so high?

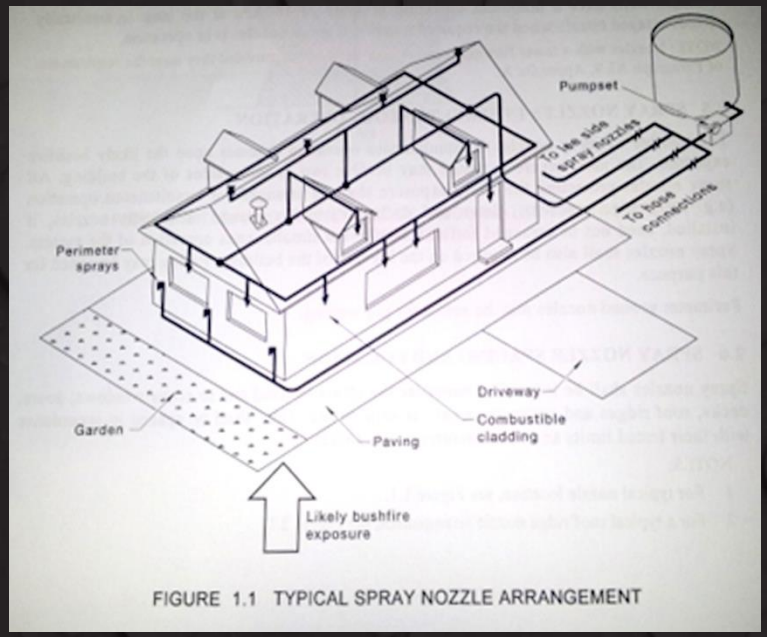


FIGURE 1.1 TYPICAL SPRAY NOZZLE ARRANGEMENT

Black Saturday 2009

173 deaths

2000 homes lost

of **173** fatalities,

40 were using water in some way.

Victoria Royal Bushfire Commission

Final Report

"The raw data revealed that a much lower proportion of houses fitted with [bushfire] sprinkler systems were destroyed."

Also reduced severity:

"If we didn't have the sprinkler system, I believe we would have been incinerated in the house in less than two minutes. The sprinkler system bought us time and absorbed the 'hit' of the firefront."

VBRC – Sprinklers NOT a Guarantee

"The Commission also notes that there were examples of people who had installed sprinklers who died while sheltering in their homes during the 2009 fires. It therefore cautions that sprinklers should be seen as a supplement to other measures and, in particular, are not a substitute for active external defence of a property. Reliance on a mechanical system alone does not appear to be sufficient to provide a satisfactory level of protection."

Embers a smaller factor:

"in comparison with other recent major fires, a much lower proportion of houses were damaged by embers only and a higher proportion of houses were damaged by direct flame contact - 20 per cent destroyed by embers only and 13 per cent by flame contact "

Light water spray systems are most effective against embers, not heat.

Types of water sprays

Distance from Fire Front

Ember Attack (100s of meters)

Flame

13.1 kW/m^2
ignition threshold
usually < 20 m

Radiant Heat

Light Water Spray

19kW/m^2

Deluge (AS 5414)

The Water Barrier

Much better:
FUEL CLEARANCE!

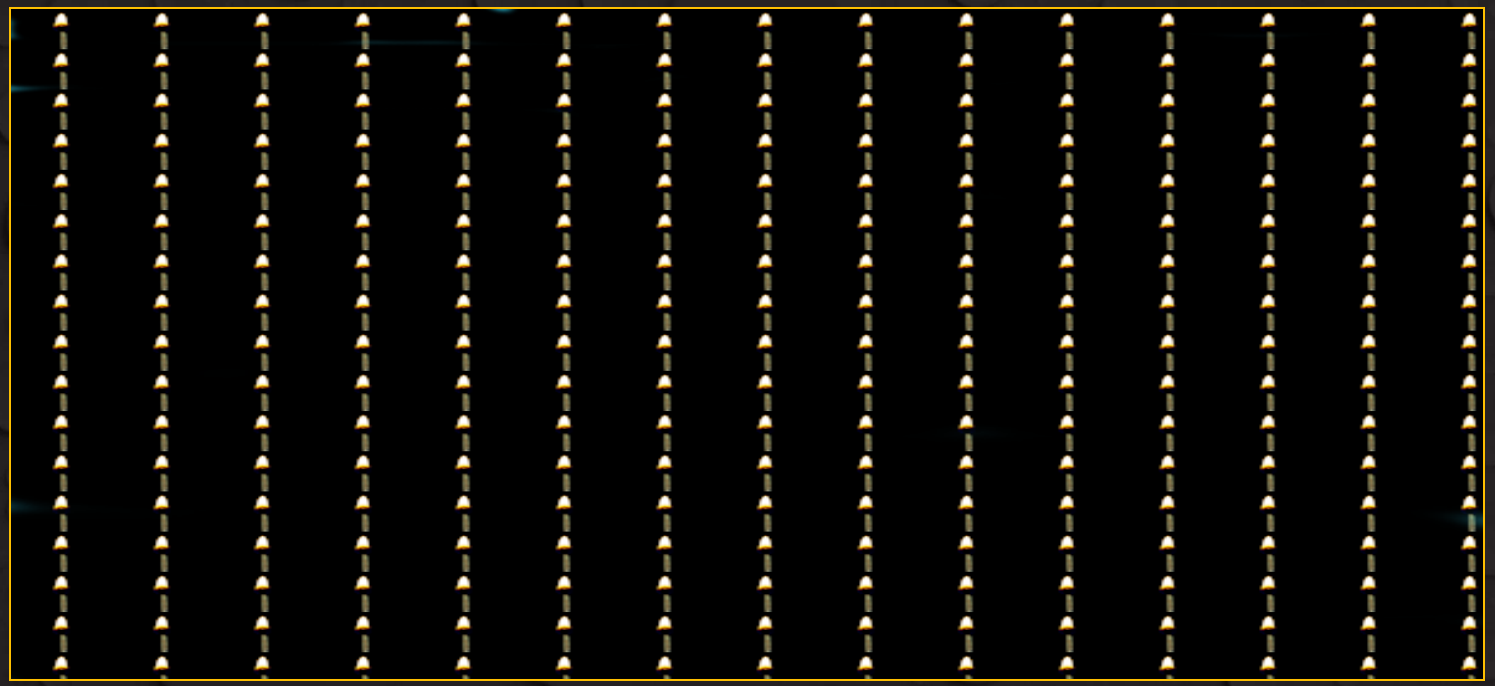
Ember protection sprays

Separate the problem of radiant heat and flame protection
(Answer: distance from fuel / vegetation management)
from the problem of firebrand protection…

How much water do you need?

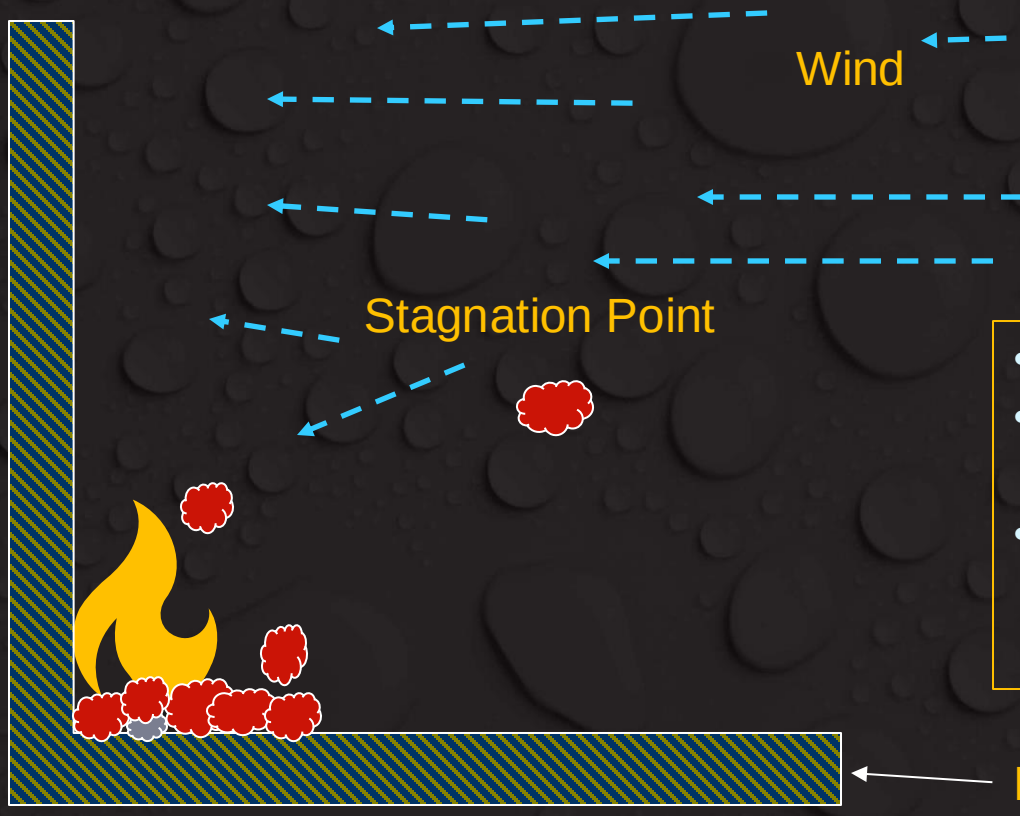
To put out a match not so much.

How much water do you need?



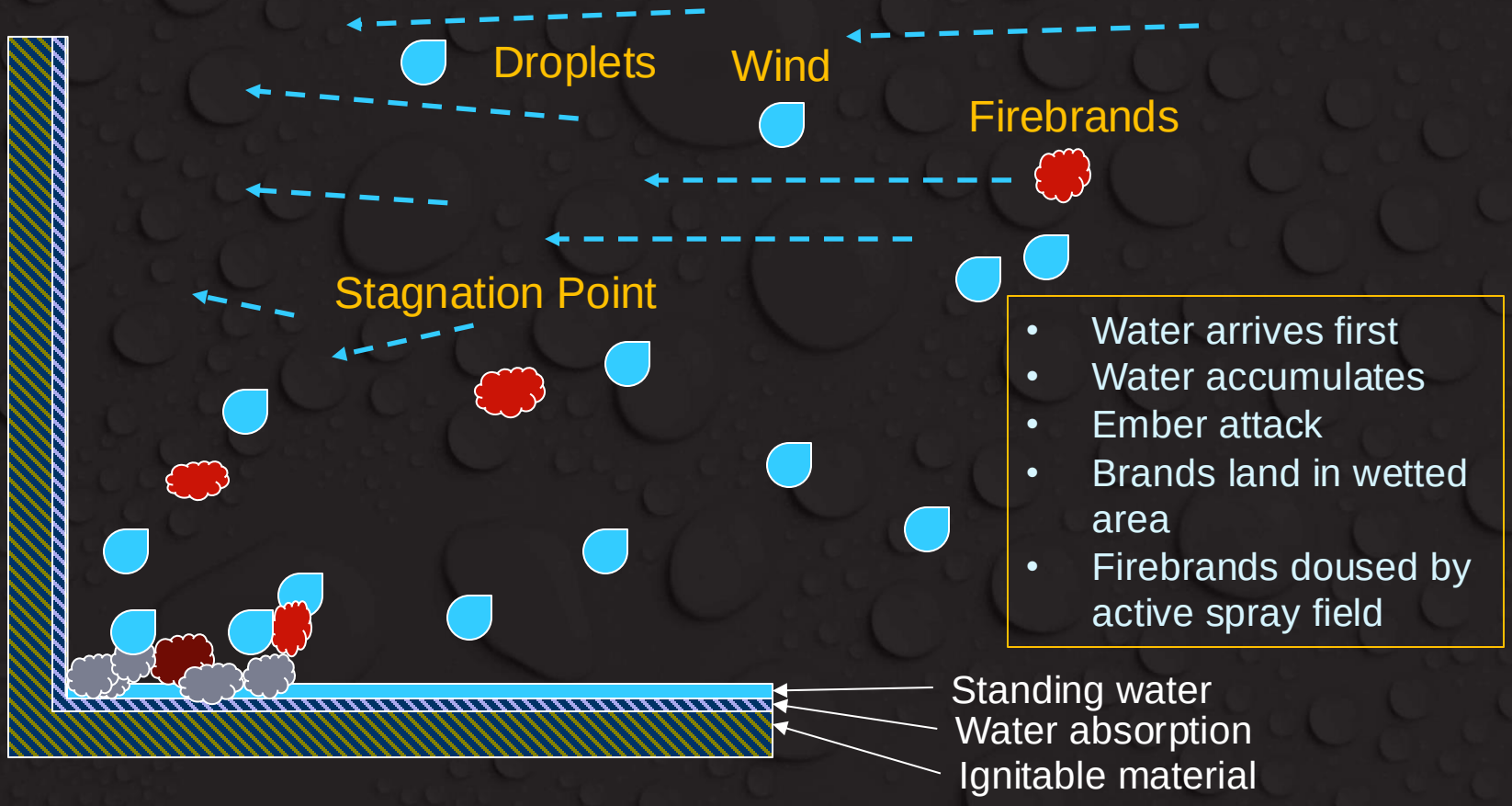
To put out a **10,000** matches not so much

Ember Attack and Ignition



- Wind drives firebrands
- Brands accumulate at stagnation points
- Accumulated brands pilot ignition (Manzello & Suzuki)

The Short and Difficult Life of a Firebrand in a Water Spray Field



- Water arrives first
- Water accumulates
- Ember attack
- Brands land in wetted area
- Firebrands doused by active spray field

Firebrand Bench Tests

- **Example:** De Beers, et. al. 2023 Fire Safety Journal

- Uses dry samples (15%)
- What is effect of wet substrate?
- How long does it take to wet substrate?
- NEED MORE RESEARCH

Water Sprays & Firebrands

- Wood cribs water threshold
  - Experiment (Grant et. al. 2000)
    1.2-3.8 g/(m^2 s)
  - Calculation (Novozhilov et. al. 1999)
    1.9-4.2 g/(m^2 s)
- AS 5414
  - 5 l/m^2-min = 83 g/(m^2 s)
- Firebrand data:
  - None
- NEED MORE RESEARCH

The Catastrophic is Typical

Assume everything will go wrong

- Loss of external water supply
- Loss of electrical power
- Loss of internet and communications
- Unexpected vulnerabilities (leaves, toys, plants)
- Extreme winds diverting sprays
- Heat and smoke threatening equipment
- Spray system components exposed to embers

How to reliably control water usage?

Water Defense and Time

The Activation Challenge

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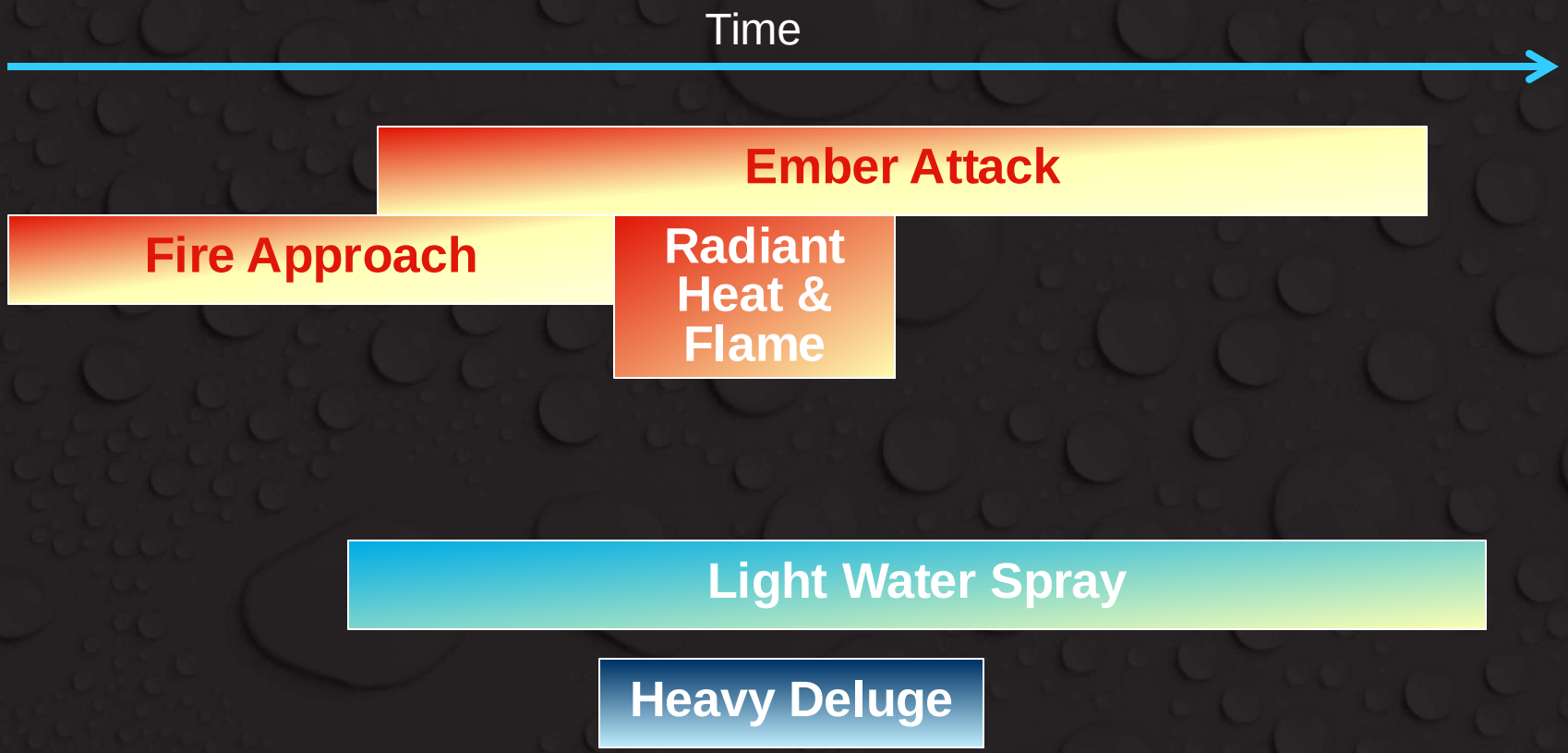
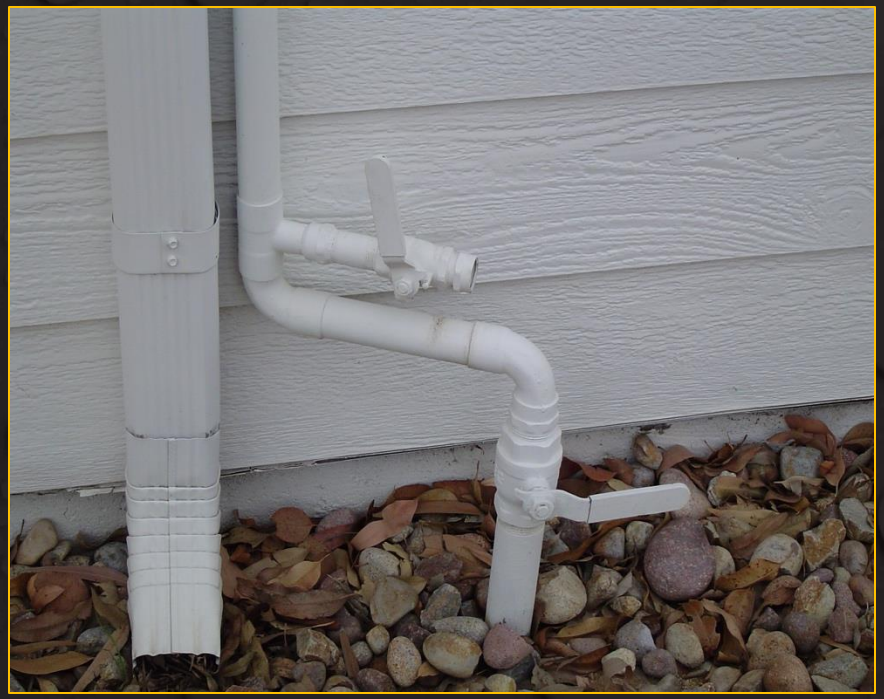
When to apply water defense



Manual Activation



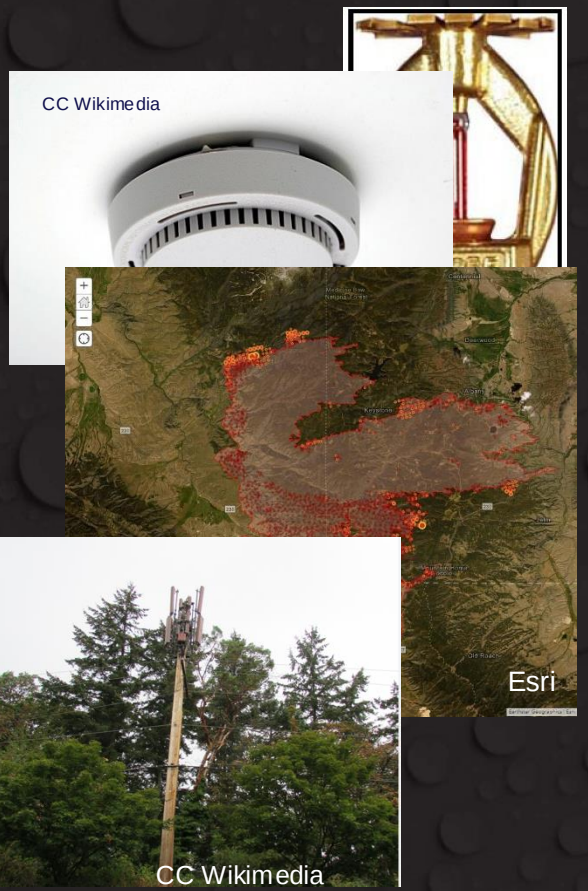
+ Simple
+ Reliable
- Requires person
  (late evacuation
  or long duration)

Automated Activation Design Requirements

- Must be active before, during, and immediately after firebrand attack
- Preserves water until required
- Must be testable and tested under real conditions
- Resilient to communication failure

Automatic Activation

- Thermal detection – good for radiant heat / flame but not ember attack
- Smoke – not correlated with ember attack
- Satellite activation - Where fire *was*
- Mobile – great if you know where fire is and networks stay up



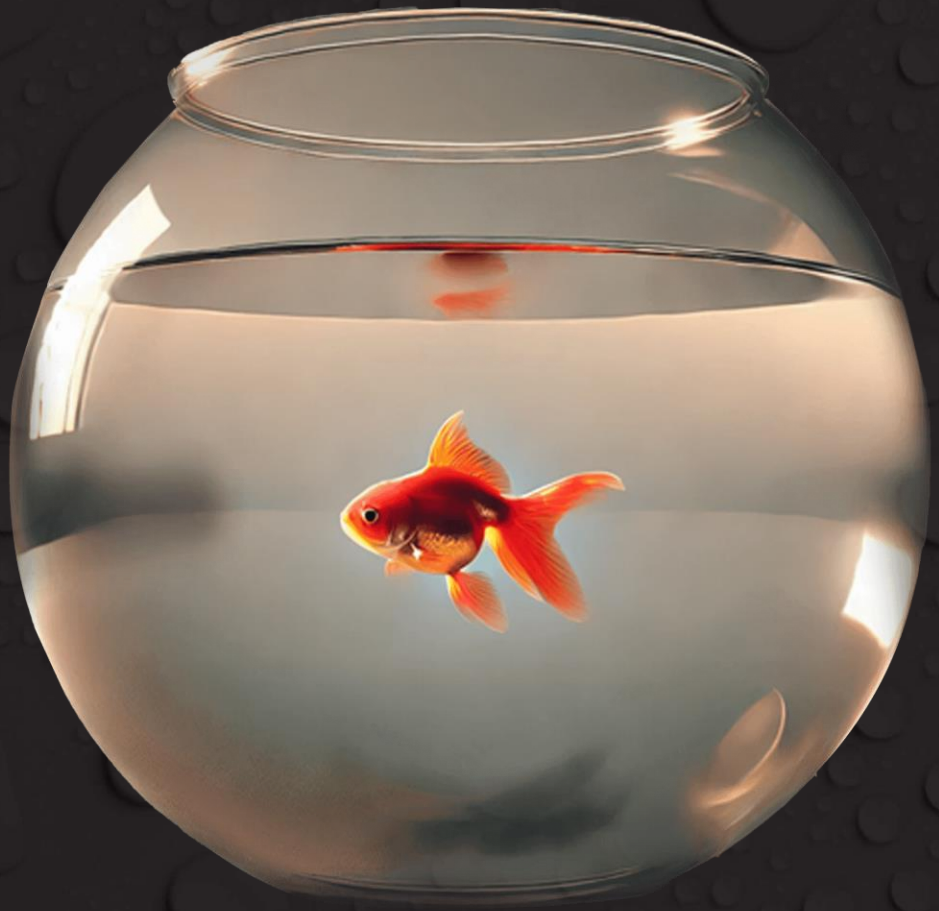
Automation Concepts

- **Secure communication**
  - Satellite with backup systems
- **"Fail-safe" concept:**
  - Tell it not only *whether* to activate but *when*
  - Robust to communication loss
- **Real-time wildfire modeling**
  - Feedback loop using perimeter data
  - CAL FIRE has this, but not currently public
- **NEED NEW TECHNOLOGIES**

Lessons

- Bushfire sprinklers can be a part of a comprehensive home hardening plan.
- Manage radiant heat and flame separately from ember attack.
- Protecting against firebrands alone can be done with an order of magnitude less water than AS 5414.
- The basic science for water and firebrands needs to be done.
  - Wetted surfaces
  - Spray density for brands
- Automated triggering needs to be designed for brand attack.
  - Stand alone
  - Fail-safe
  - Testable

Thank You



Slides available from:

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