Perimeter SOLUTIONS
Quality Products. Exceptional Response.

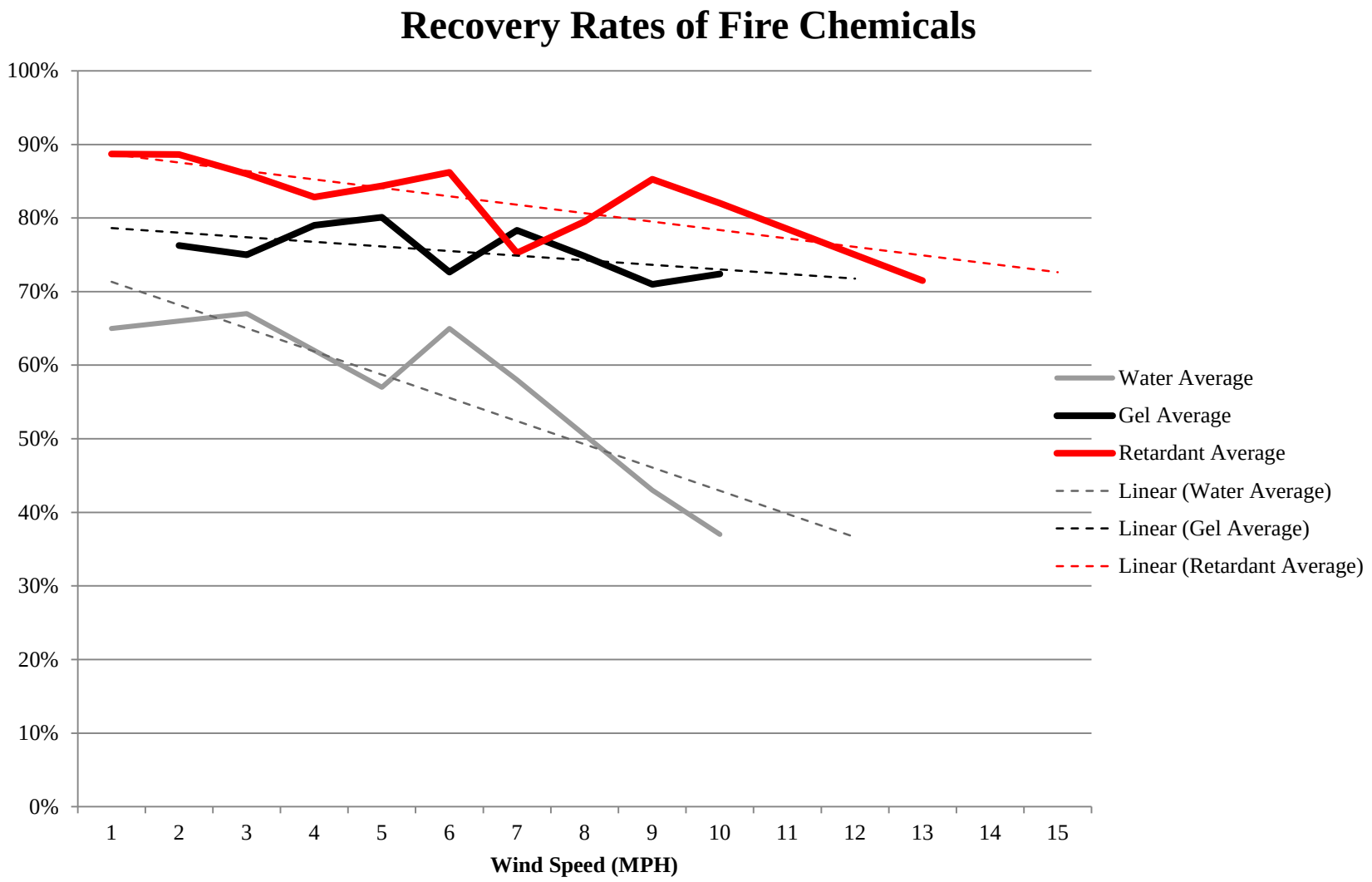
Advancements in Fire Chemical Technology

March 5, 2020

Why Chemicals?

- Why Aerial Attack?
  - Speed
  - Time
  - Coverage
  - Flexibility
- Water is inherently inefficient
- Class A Foam provides penetration and time
- Retardant enhances Time, Coverage and Flexibility

Recovery Rate



Fire Chemical Development

From Safe, Effective and Environmentally Friendly

To

Safer, *More* Effective and
Environmentally *Friendlier*

Todays products are the safest, most effective and environmentally friendly ever…But still room for improvement

History of Fire Chemicals

- 1930's to 1950's - Water and "Wet Water"
- 1955 to early 1960s - borate then bentonite
- Early 1960s – gum thickened phosphates and clay thickened sulfates and then unthickened polyphosphate
- 1975 – Fugitive colored retardants
- Early 1980's
  - Gum thickened sulfate
  - Gum thickened phosphate/sulfate blends
  - Aerial use of Class A foam (helicopters and scoopers)
- 2003 – First gum thickened LC

What drives innovation?

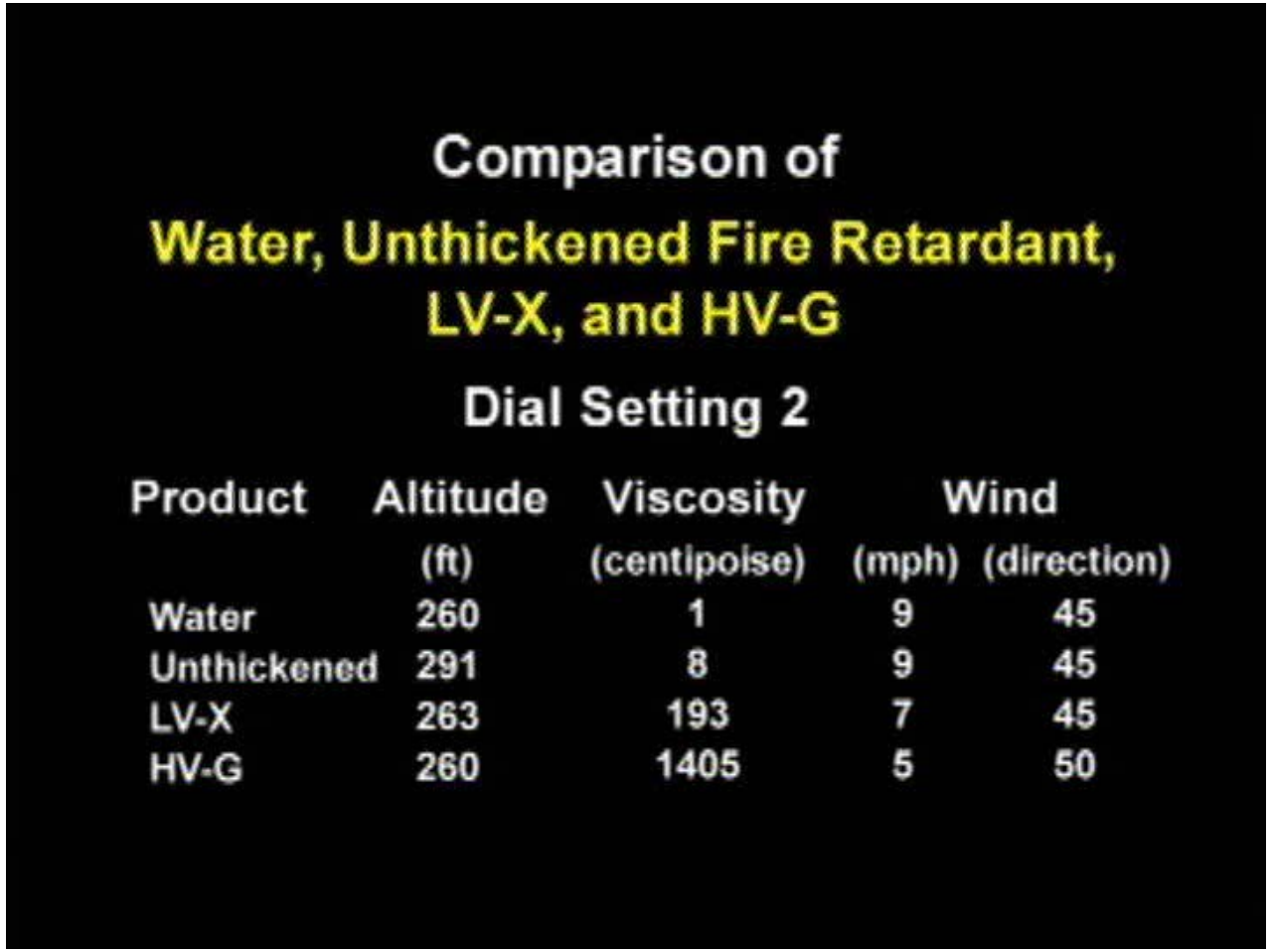
- Safety and environment
- Newer, faster, larger airtankers
- Effectiveness
  - More stable
  - Better drop characteristics; higher recoveries
  - More visible

Advancement in Tankers

Advancement in Retardant

- 2003 First Gum-Thickened LC
- Safety and Environment Improvements
  - All phosphate
  - Lower use rates
- Effectiveness
  - Better gums
  - High Visibility Fluorescent Pigments
- Airtanker Support
  - Mixing/Loading Technology
  - Mobile Aerial and Ground Operations

Drop Characteristics



Visibility

New “Fx” High Visibility Fugitive

Older Generation Fugitive

Visibility

As dropped

4 Weeks

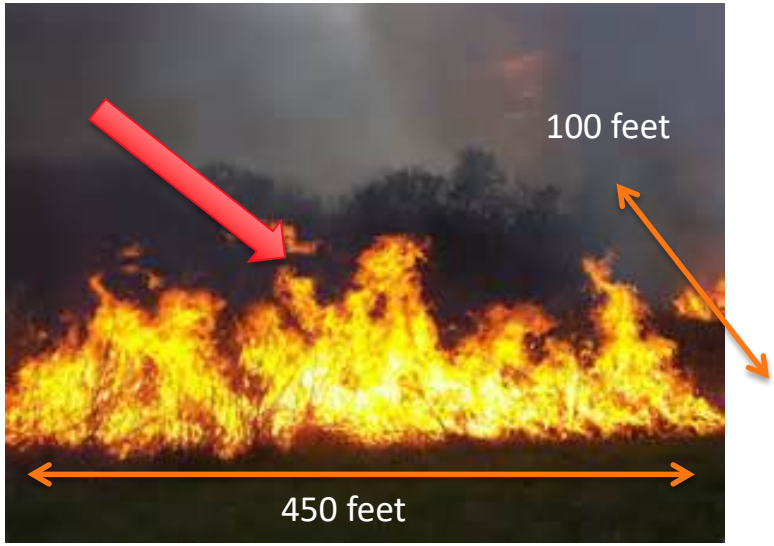
Retardant for Direct Attack

- Based on recovery, retardant will deliver more water to the fire than water or foam
- Once dry, the retardant prevents re-ignition by rendering the fuel non-flammable
- In the presence of retardant, the hot fuel decomposes into Carbon and Water, releasing additional water for cooling

$$C_6H_{10}O_5 \longrightarrow 6C + 5H_2O$$

- For each ton of fuel burned, 135 gallons of water is released

Suppression



One Acre fire:

- Fully involved can generate over 100M BTUs
- 550 feet (170 meters) of flame front can generate 10M BTU per minute
- 1100 gallons of water per minute is required to fully absorb the heat along the flame front
- 11,000 gallons of water required to extinguish a one acre fire

Hurdles

- Low recovery rates reduce the amount of water that reaches the fire
- Hot spots could remain causing rekindling
- Incomplete extinguishment allows fire to escape via untreated fuel
- Due to evaporation water may not reach the fuel itself, where it is most effective

Retardant for Direct Attack

Long-term retardant will make more water available for cooling and dilution than other tools, and will require fewer tanker drops, reducing aircraft cost.

For Each Gallon Dropped	Retardant	Gel	Foam	Water
Water Contained	0.90	0.98 to 0.99	.990-999	1.0
Recovery at Target	70% - 90%	70% - 80%	35% - 65%	35% - 65%
Water on the Fire	0.65-0.80	0.70 – 0.80	0.35 – 0.65	0.35 – 0.65
Effective gallons from AT802	**520-640**	**560-640**	**280-520**	**280-520**
AT 802 drops req'd per minute	**2**	**2**	**2-4**	**2-4**
Additional water provided from fuel	**135 gallons per ton of fuel burned**			

What’s next?

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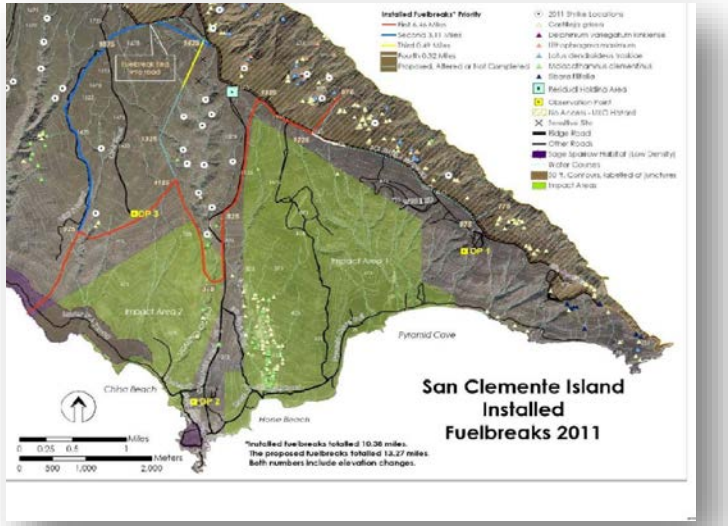
2020 and Beyond – New Applications

Prevention and Protection

- Ignition mitigation
- Critical infrastructure protection
- Egress and Ingress
- Home protection
- Prescribed burns



2020 and Beyond – New products

- New Liquid Concentrate
  - Improved safety and environmental profile
  - Increased stability
- Durable Retardant (for ground application)
  - Improved weathering
- Future development in improved drop characteristics
- Mobile retardant systems for international deployment