

Reading Smoke – the Sequel



- **Cours/Activity:** September Monthly Training #2 Reading Smoke
- **ISO Code:** Should populate to Company Level Training
- **Location of Training:** Location you trained, typically your Firehouse
- **Date/Hours:** Date you completed the training and 2.5 hours
- **Instructors:** Person or Persons providing the training for the company
- **Attendees:** Enter everyone's name, including those listed as the instructor, yes people can be listed as both attendee and instructor.
- **Description:** Tell us what you did!

If you have a prepared training program that would benefit the department, send an email to Chief Steve Clegg steven.clegg@indy.gov the training will be reviewed and sent out department wide via monthly training if approved

“Sequel”?



- “Reading Smoke” is far from absolute – therefore there is room for interpretation
- Many have “added” fingerprints to the curriculum – helping the the information become more street friendly





The Sequel Plan



- Give you something to help at your next structure fire
- Review the basic process
- Update/refocus some key points
- Offer some “short cuts”

The Basic Process

Reading Smoke can help you answer 3 questions:

1. Where, specifically, is the fire?
2. How big or intense is the fire?
3. How fast is it changing? (rate and severity of fire spread)

Basic Process – the Science

3 concepts help you read smoke:

1. Smoke is **FUEL**
2. The fuels have changed
– **more continuity and explosiveness than previously taught**
3. The smoke has trigger points

Smoke is Fuel - Particulate

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2022-01-21 19:00:44

If smoke is 70% solids – then interior compartment fires will go “under-ventilated” as the solids displaces air. That equates to a more explosive environment when air is finally introduced. Soot is carbon – it can burn. Ash contains trace minerals and metals and wont burn. Ash, however, can carry amazing amounts of heat.

- 70% of smoke is particulate
- Soot (Black)
- Ash (White)
- Fibers/dust/pulp



An aerosol is a suspended or propelled liquid. Heat is the propellant.

Smoke is Fuel - Aerosols

- Water
- Hydrocarbons (black oil droplets)
- Some oils have self-ignition temps as low as 460°F



Consider this...

Compare the flammable ranges and the temperatures. Smoke is ignitable from 1-74% mix in air and as low as 450F! These gases are the high in volume in typical fires.

The following gases create “*ladder fuels*” within smoke (remember, there are particulates and aerosols also).

Gas	Self-Ignition Temperature	Flammable Range
Acrolein	450°F	3-31%
Benzene	928°F	1-8%
Hydrogen Cyanide	1000°F	5-40%
Carbon Monoxide	1123°F	12-74%

Remember...

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Crawling in zero-visibility smoke has never been more risky. You may not see the flame wave coming until it's too late. Keep smoke cool!

- Your gear TTP masks heat initially – you can't feel 450°F for minutes – yet the smoke you are crawling in is ignitable!
- The thicker the smoke – the more continuity of fuel between you and the fire.

The big change started in the 90's and has become continually worse.

Concept #2 – Fuels have changed!



- More synthetics
- Lower density/mass
- High surface-to-mass
- This adds up to **MORE** smoke

Concept 3: Triggers for Smoke Ignition

Right Temperature & Right Mixture

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Remember the ladder fuels?



These triggers are arguable – as are the definitions of hostile fire events like flashover and backdraft.

Temperature Triggers



Flashpoint = smoke explosions

Firepoint = rapid fire spread

Ignition Temperature = flashover and backdraft

Mixture Triggers

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2022-01-21 19:00:46

"Too Rich" seems to be the situation in most building fires.

Too Rich . . .

Too Lean . . .

Just Right . . .

Other Prerequisites to Reading

Smoke

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Turbulent smoke: box can't absorb more heat – a flashover warning. Other words for turbulent include agitated, boiling, or angry. "Laminar" means smooth, soft-billowing, or straight-line smoke movement. If the box is absorbing heat, it will cause smoke to smooth out (become laminar) as it moves through the building. If you have a video example – show it here!

You must be able to determine....

- The Rate of Change – getting better or worse in seconds or minutes.
- Is the “box” absorbing heat? **Laminar vs. vs. TURBULENT flow**

The “Reading Smoke” Process

Flames will attract your attention! Try to look past them because the future of the fire is painted by the smoke.

Process Rules:

1. Nothing is absolute
2. Compare ventilation openings (*restricted or unrestricted, smoke or no smoke*)
3. *Watch the smoke –not the flames!*

The “Reading Smoke” Process



Don't Forget:

- Turbulent vs. Laminar
- Measure Rate of Change
- Smoke is FUEL!

Previous lessons taught a four-step process. We just simplified it.

The 3-Steps for “Reading Smoke”

1. Inventory & compare smoke attributes: *volume, velocity, density, and color*
2. Factor in influences that change the meaning of WVDC
3. Answer the questions: Fire location? Size of fire? What will it do next? (*better or worse/seconds or minutes*)



STEP 1: Inventory and compare attributes

This is easy to say but hard to capture because firefighters use "light and heavy" to describe smoke. It takes practice to break that habit and get good at reading smoke.

- Volume
- Velocity
(Pressure
)
- Density
- Color



Volume of smoke tells very little about the fire. It merely sets an impression.

VOLUME

- Gives an impression
- Establishes relativity to the “box”
- Remember: a small volume of smoke from a very large box is significant
- Volume is a source of pressure (velocity)



VELOCITY (Pressur

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Volume-pushed smoke will immediately slow down when it leaves a building. Heat-pushed will keep its speed. To find the fire location, compare like-sized openings: wherever you see the fastest, longest duration velocity is closer to the fire. Be careful here: the size of opening ultimately determines how fast smoke can leave. A good rule of thumb: look for the fastest smoke from the most-restrictive opening — that's probably where the fire is.



- How fast is the smoke leaving?
- **Turbulent or Laminar?**
- Is laminar smoke heat or volume pushed?
- Compare velocity from like-sized openings to find fire location

Density

The thicker the smoke – the more likely you are to have a spread event – and the more dangerous (intense) the event will be.

□ Most Important Factor



Color

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Velocity trumps color because smoke can be filtered over distance or through cracks (carbon and hydrocarbon makes smoke black – these are very “sticky” and will deposit on things as smoke moves. The further smoke moves through a building, the lighter it will be.)



- Tells Stage of **Heating**
- Should compliment velocity to find location of fire
- “Brown” Smoke is usually unfinished wood being heated
- Remember, smoke color can be *filtered* over distance or through resistance

STEP 2: Factor in Influence

- Container (*defines the significance of VVDC*)
- Weather

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Smoke that is low volume, slow velocity, thin, and white sounds like a small fire. That is true only if the "box" is small. The same attributes from more than one location of a very large box can mean a huge fire. Weather impacts smoke also. Wind can alter the attributes. Humidity creates smoke movement resistance. Air temperatures impact smoke speed. As a rule, cold/humid air will cause smoke to fall quickly and stay together. Conversely, hot/dry air will cause smoke to rise and disperse easily.



STEP 3: Answer the Questions

- Where's the fire?
- How big or Intense is the fire?
- How fast is it changing? (*Getting better or worse – in seconds or minutes?*)



Update/Refocus



- Velocity trumps color
- **ANY** thick, fast moving smoke is ignitable
- Zero visibility makes you a slave to your environment

Update/Refocus

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Human life thresholds: 300 degrees F
for 1 minute = death (not ALS savable).

Turbulent smoke is ready
to flash – and
indicates that floor
temperatures are past
human life thresholds
(zero rescue profile!)

**Manage it – but reduce
your risk-taking!**

Update/Refocus

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"Vent and cool" needs to be our mantra. Interior fire attack unsupported by ventilation is foolish in today's fire environment.



Opinion: Ventilation has never been more important and needs to be our #1 tactical priority (*make the building behave!**)

**Tom Brennan – we'll never forget you!*

Short Cuts (not absolute)

- Black/Thick/Fast = heat and explosive
- Black/Thin/Fast = flame near
- White w/Speed = hot – but fire is distant
- Uniform speed/color (steady flow & light color) from many places = deep seated fire
- Brown = unfinished wood being heated
- Turbulent = Flashover

