



HYDROCARBON PROCESSING®

IRPC

October 2-3, 2024 | DoubleTree by Hilton, Greenway Plaza, Houston, TX

The background image shows a complex industrial facility, likely a refinery or chemical plant, at night. The scene is filled with intricate piping, scaffolding, and various industrial structures. The lighting is a mix of deep reds and cool blues, creating a dramatic and somewhat somber atmosphere. Overlaid on the image are several large, wavy, semi-transparent shapes in shades of red, orange, and blue, which appear to be part of a graphic design or data visualization. The text is centered and rendered in a clean, white, sans-serif font.

Optimizing Combustion Processes for Safety & Efficiency

Optimizing Combustion Processes for Safety & Efficiency



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AMETEK PROCESS INSTRUMENTS
COMBUSTION PRODUCT MANAGER



Agenda

- Brief Combustion Overview
- Setting Safety Margin at the Burner
- Identifying The Optimal Efficiency Point
- Increasing Safety During Start-up & Process Upset

Why optimize combustion processes?

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- Fired equipment provides heat & power in nearly every industry – including boilers, heaters, oxidizers



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Why optimize combustion processes?

- Fired equipment provides heat & power in nearly every industry – including boilers, heaters, oxidizers
- Many processes will continue to use combustion to effectively generate high temperatures
- Optimized combustion increases safety while reducing fuel costs and CO₂ & NO_x emissions

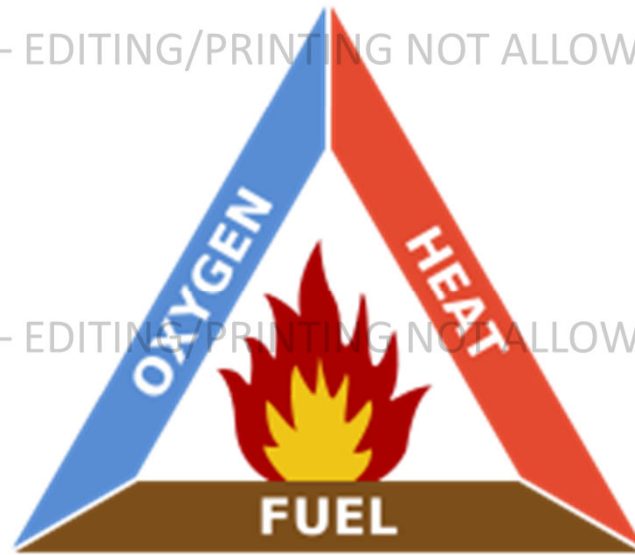
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Brief Combustion Overview

Combustion starts with the Fire Triangle

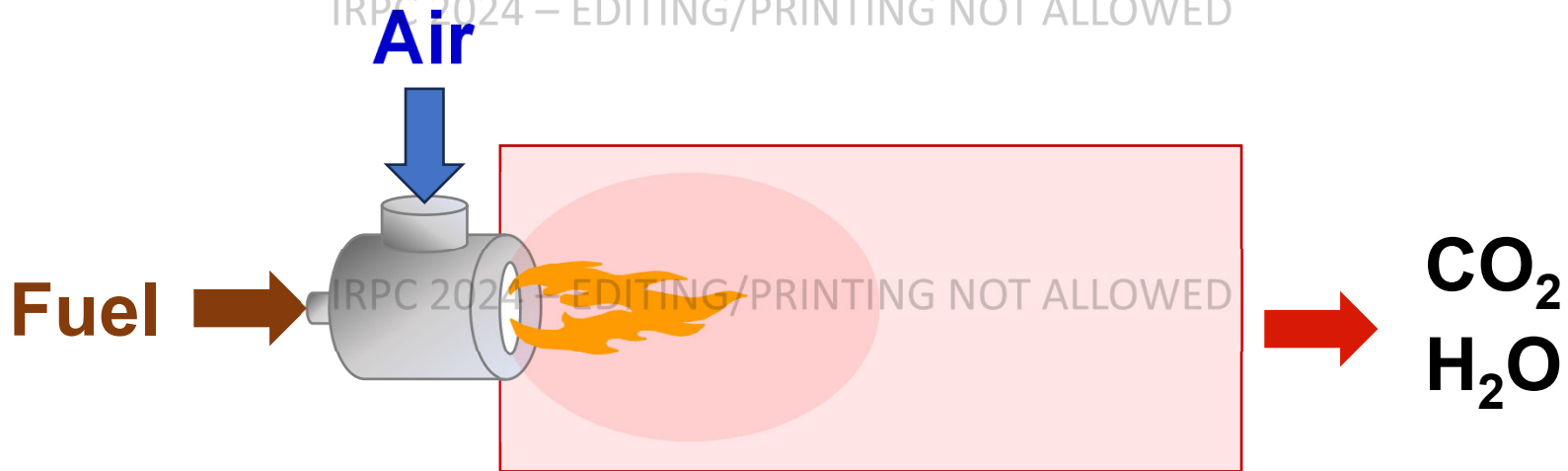
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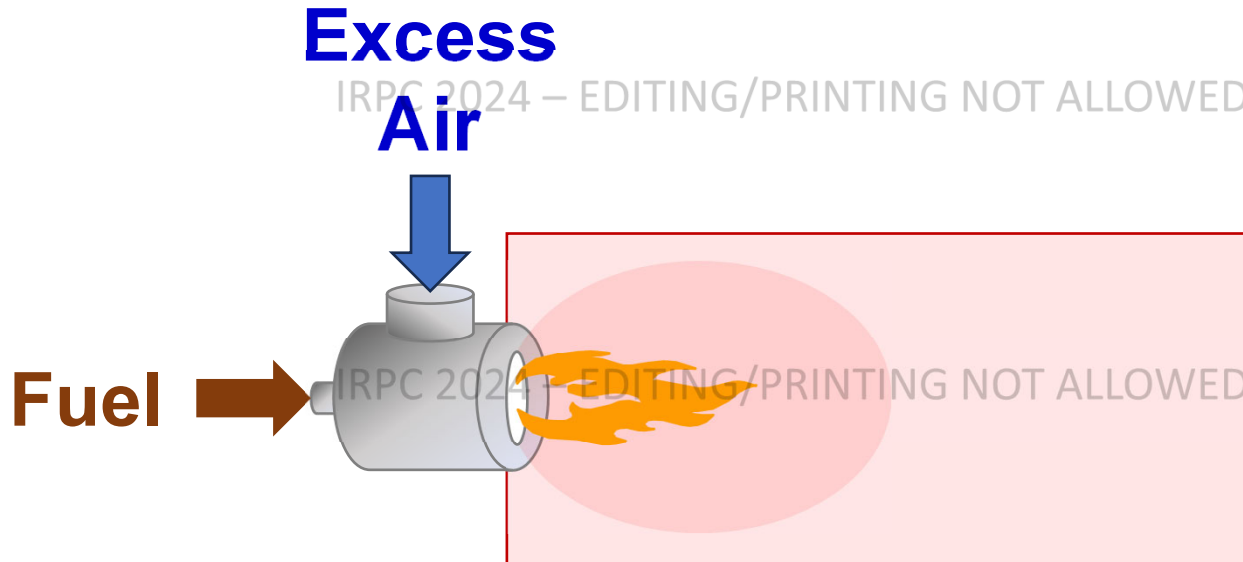


In a Perfect World, Air & Fuel react fully

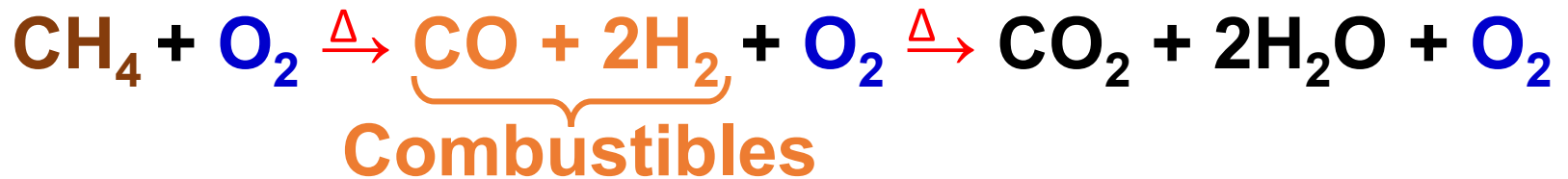
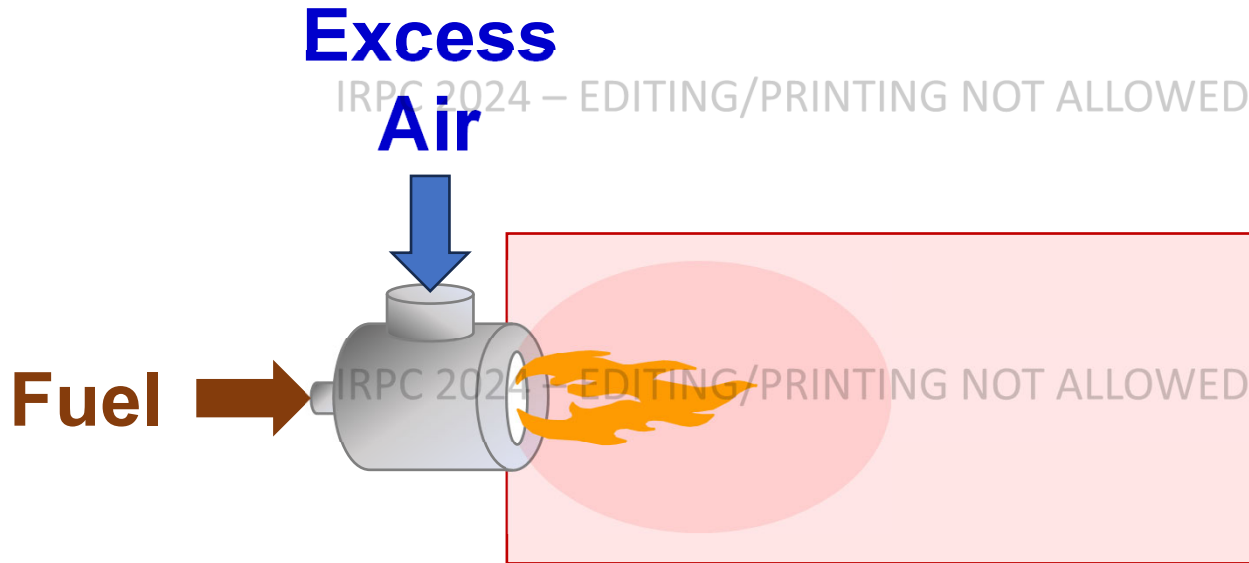
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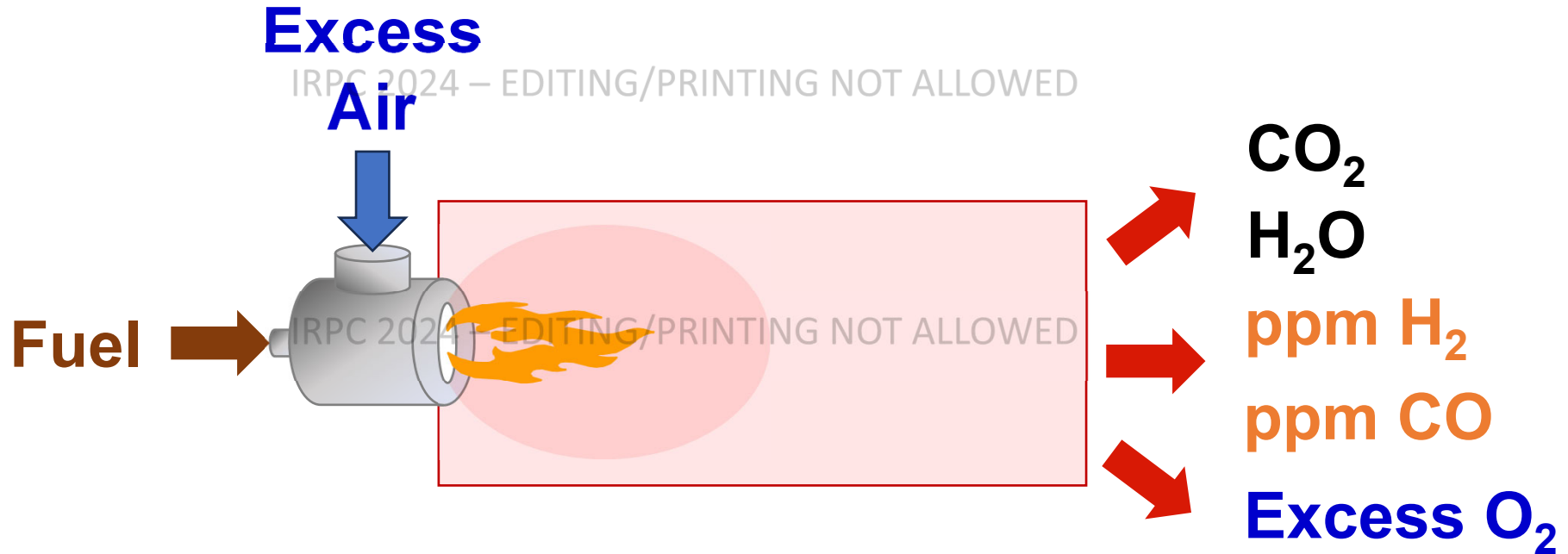
In reality, an excess of air is needed



Combustibles are formed as well

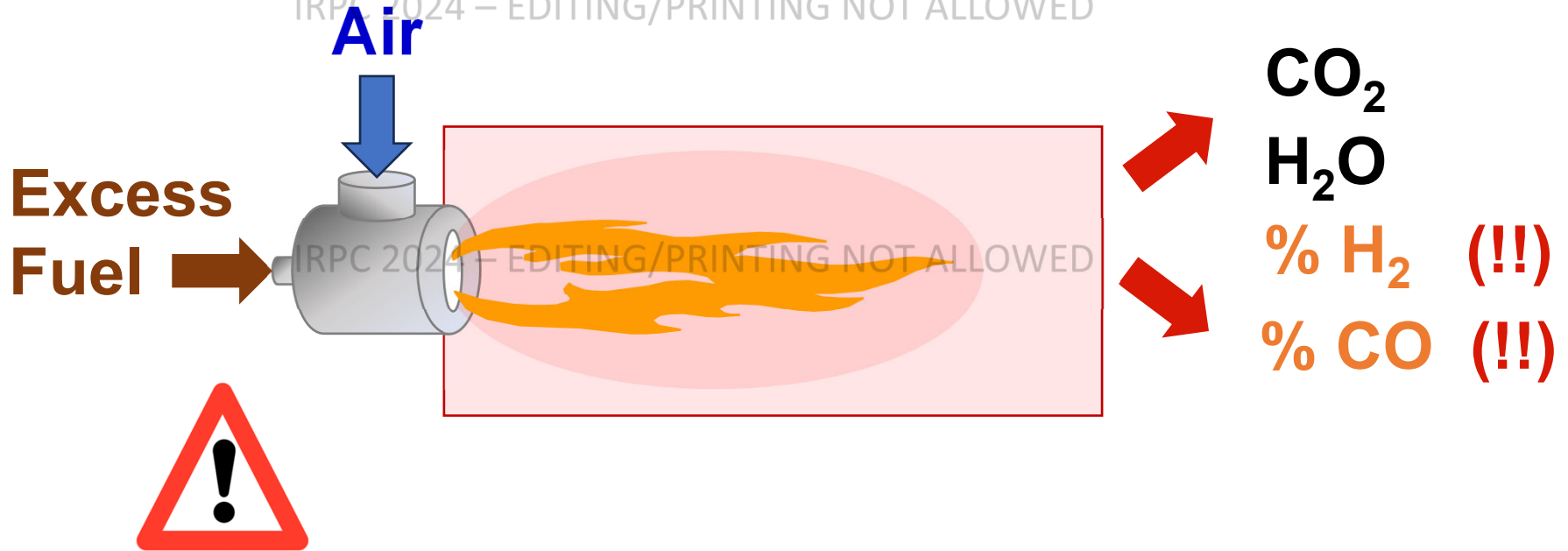


Typically, there are ppm Combustibles



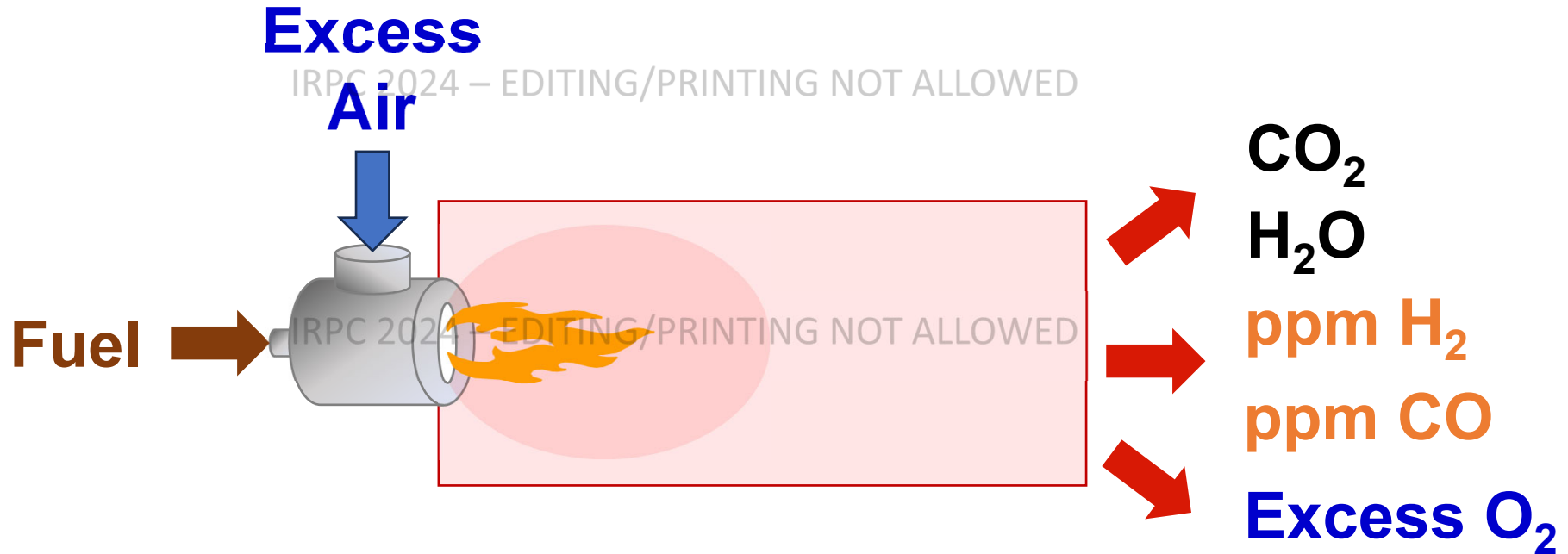
Without enough air, unsafe conditions

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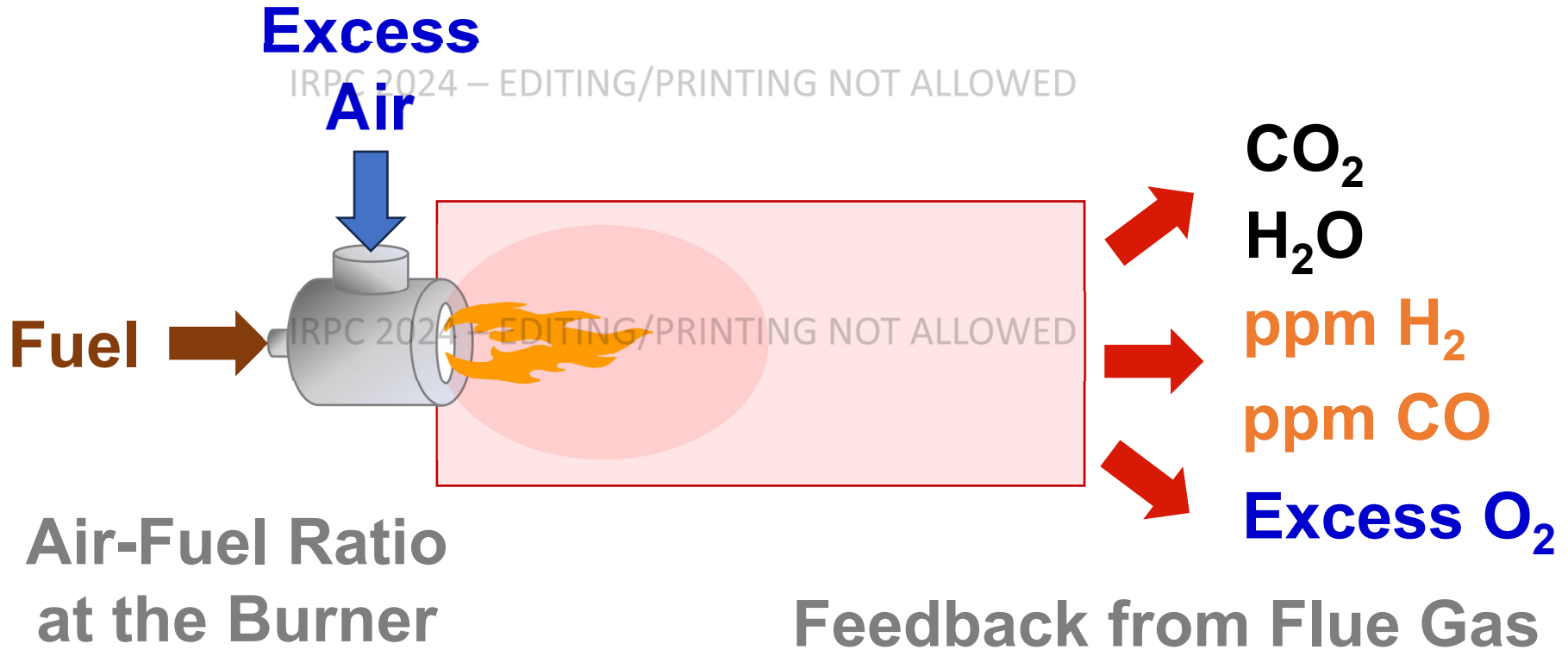


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It is important to have an excess of O_2



Leverage these for safety & efficiency

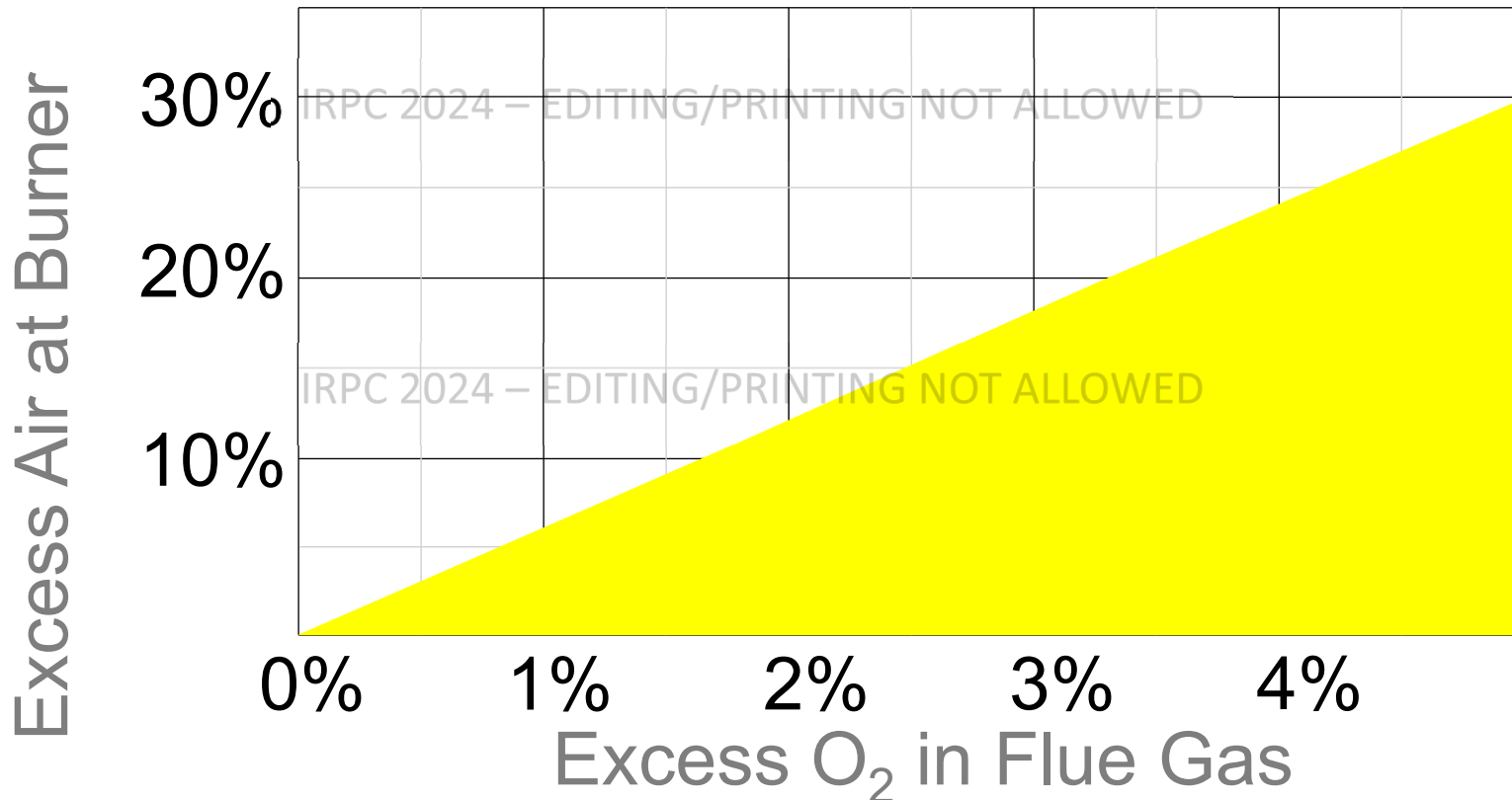


The background of the slide is a photograph of an industrial refinery or chemical plant. The image is heavily stylized with a red color cast and semi-transparent blue and orange curved overlays. The scene shows a complex network of pipes, scaffolding, and industrial towers. In the center, the title text is prominently displayed in white. A faint watermark is visible across the middle of the image.

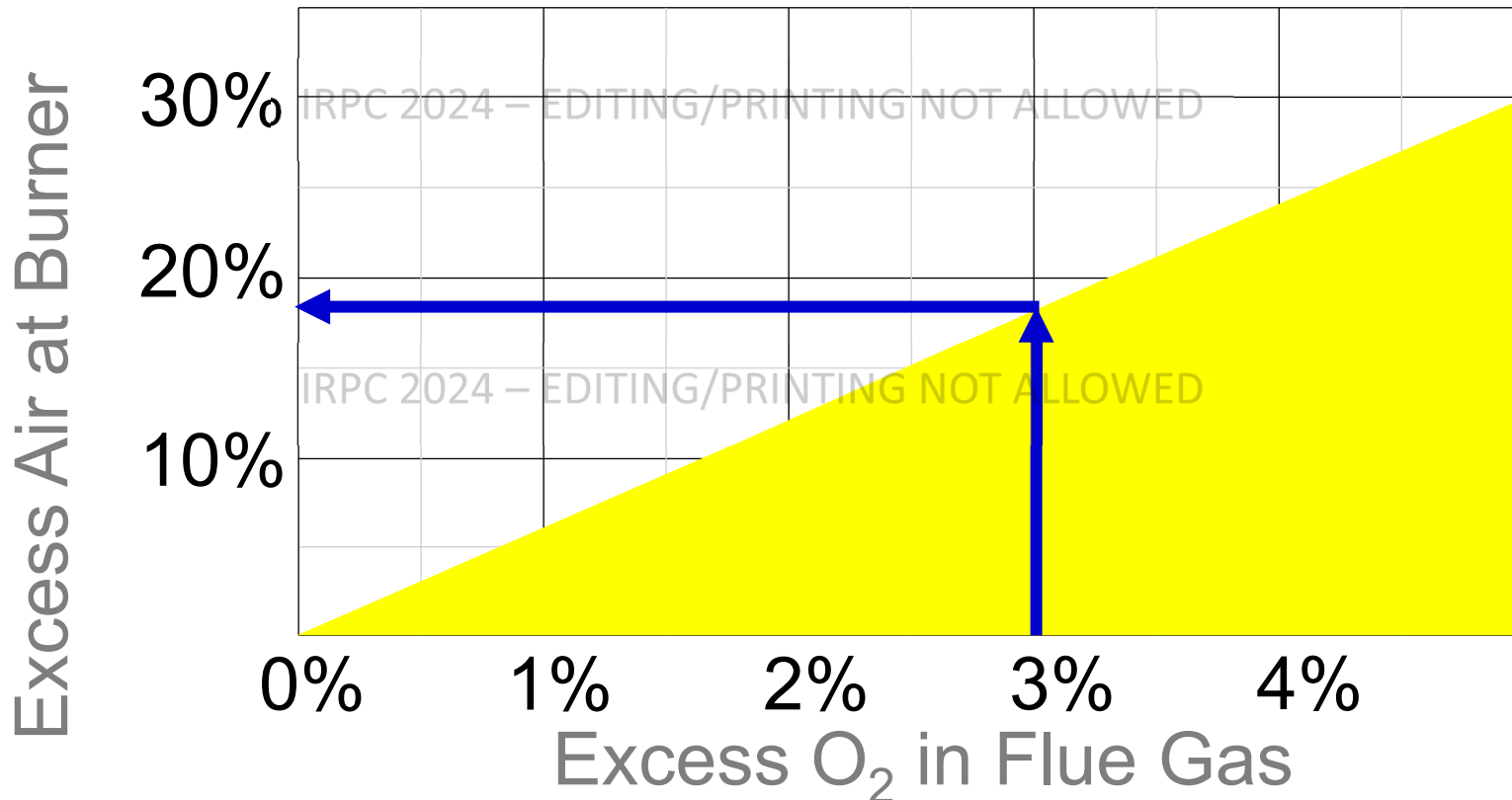
Setting Safety Margin at the Burner

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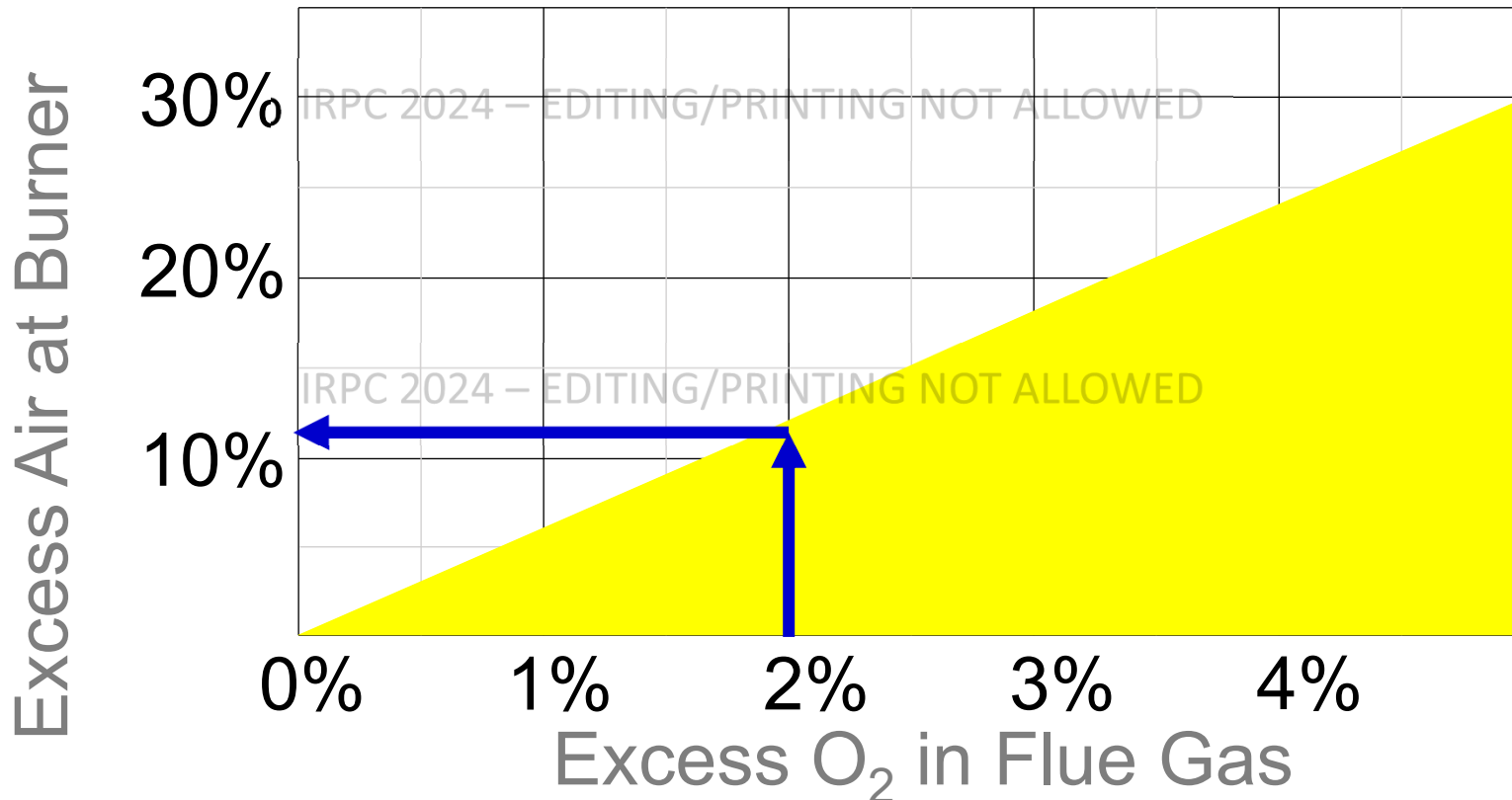
There is a direct correlation for **Air & O₂**



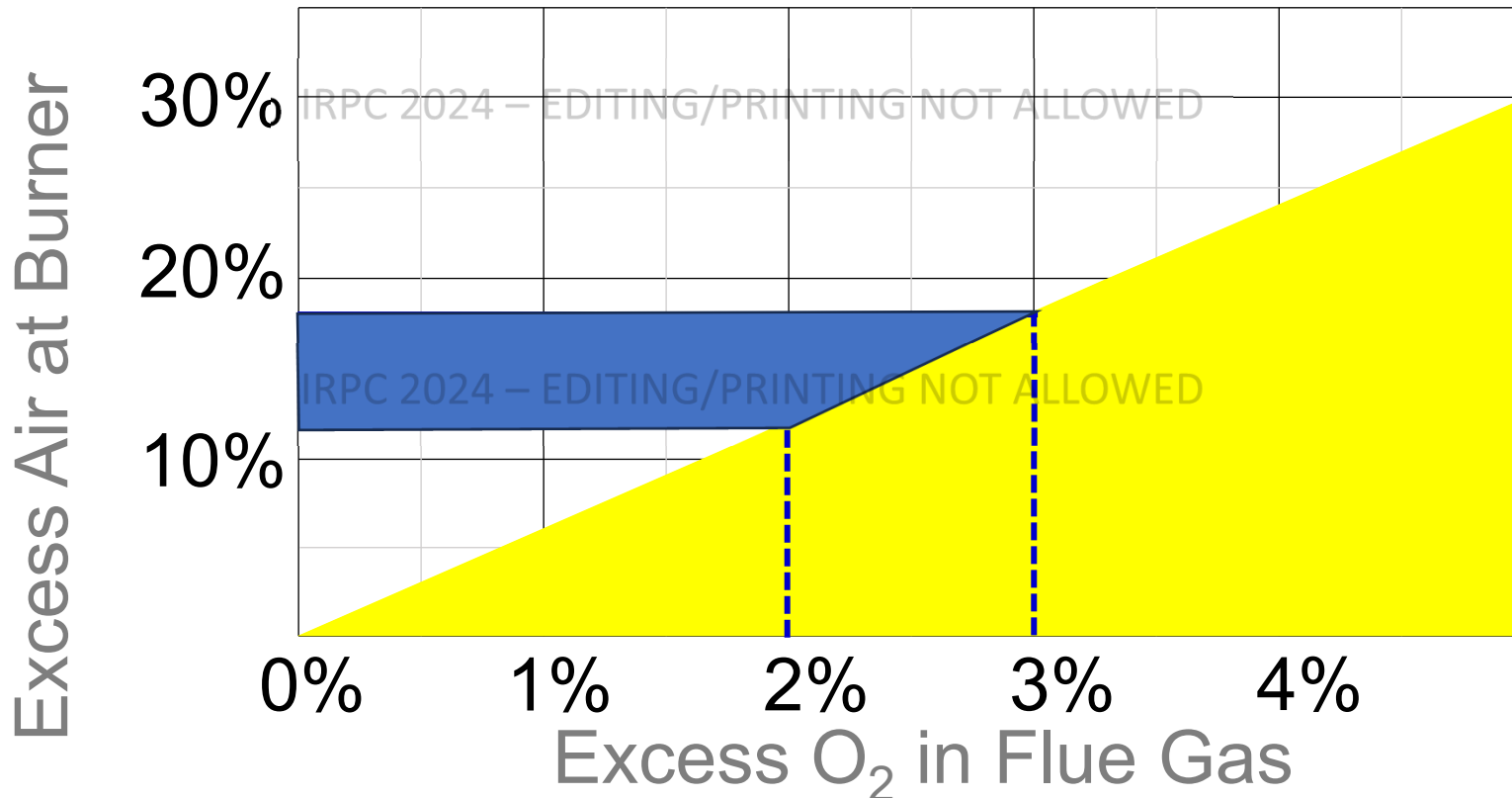
3% XS O₂ in Flue Gas is ~18% XS Air



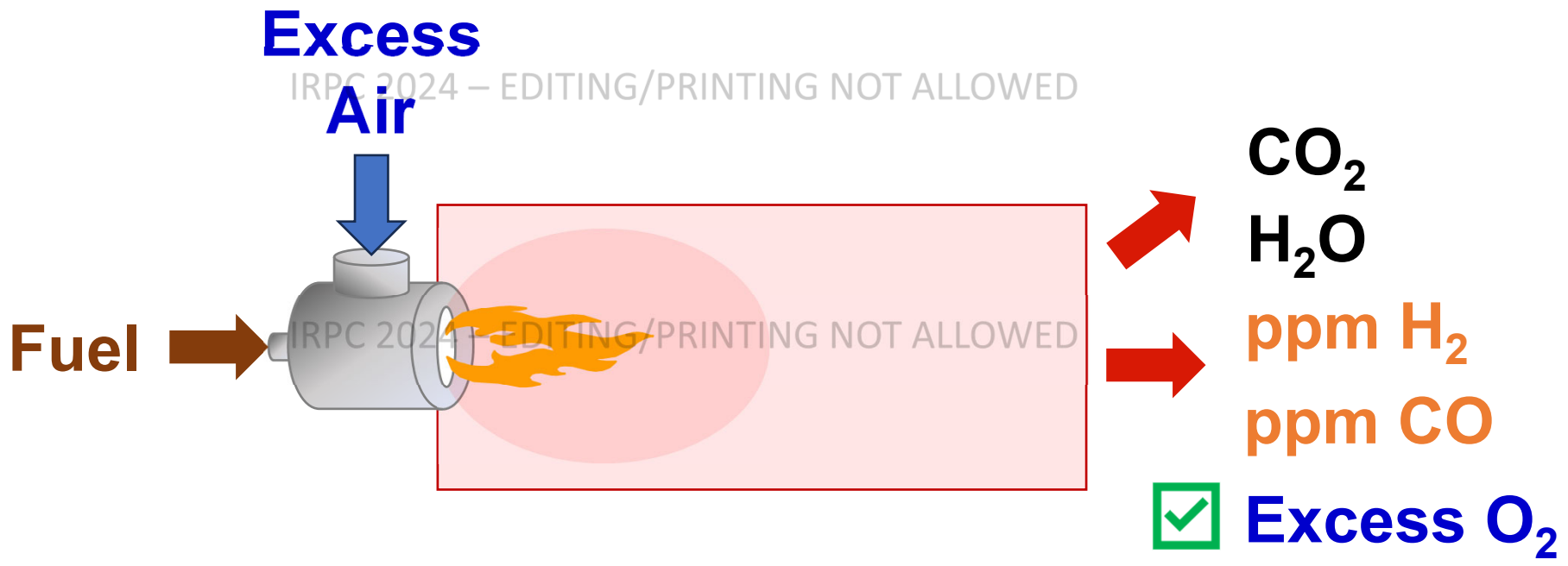
2% XS O₂ in Flue Gas is ~12% XS Air



Excess O₂ correlates to safety margin



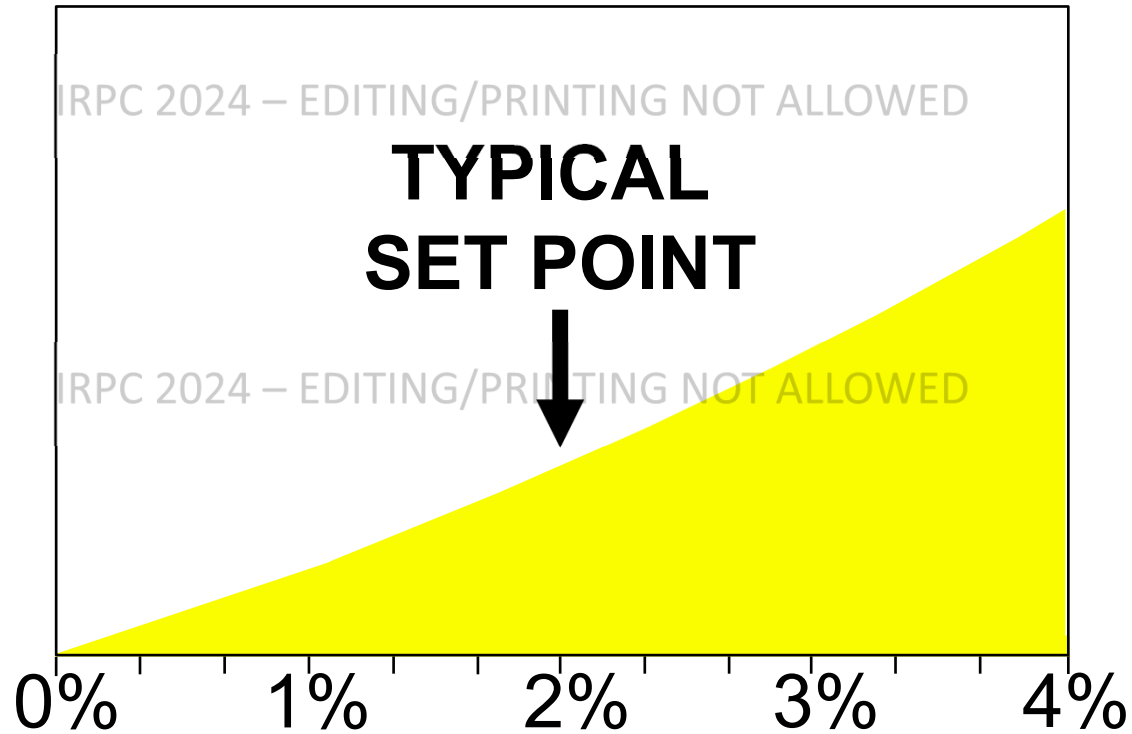
Excess O₂ gives an operational setpoint



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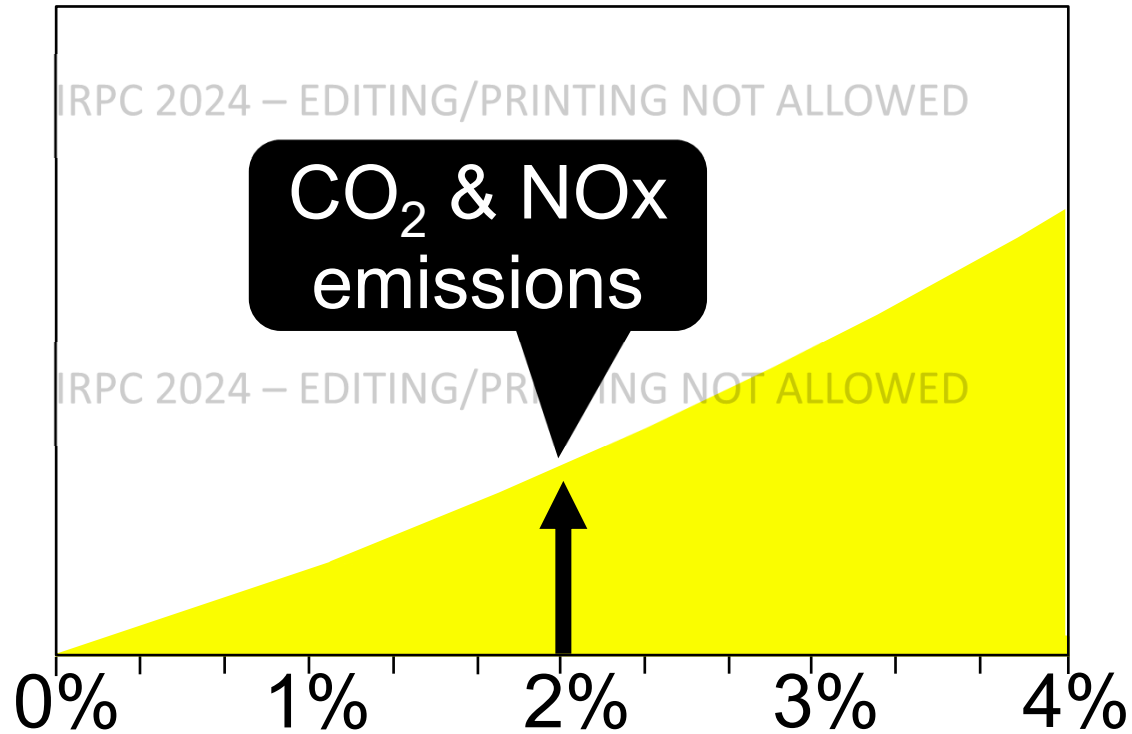
Identifying The Optimal Efficiency Point

Again, excess O_2 provides a setpoint



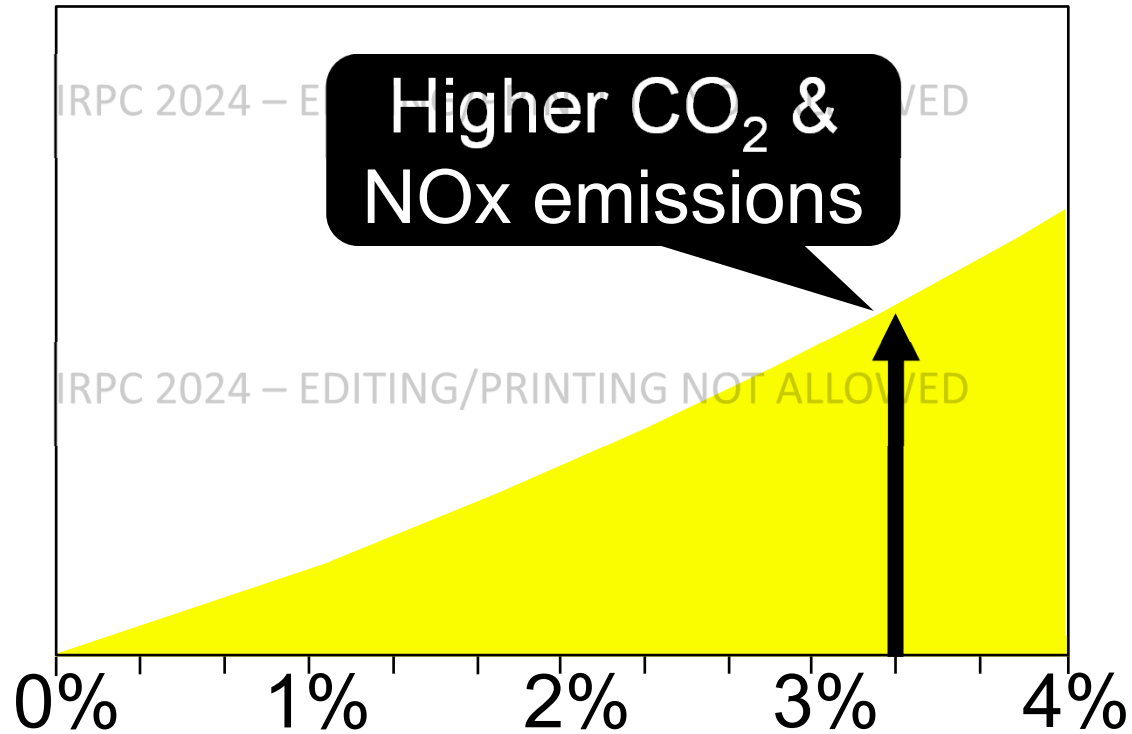
(For illustrative purposes only)

And this setpoint generates emissions



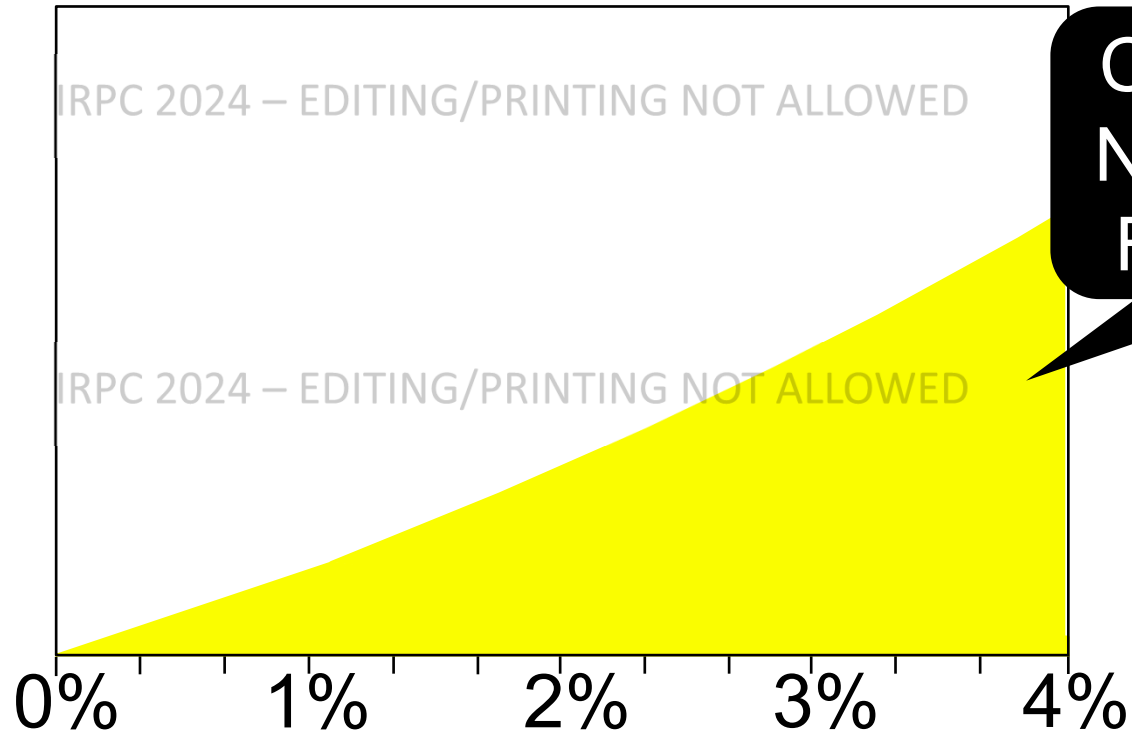
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High excess O₂ makes more emissions



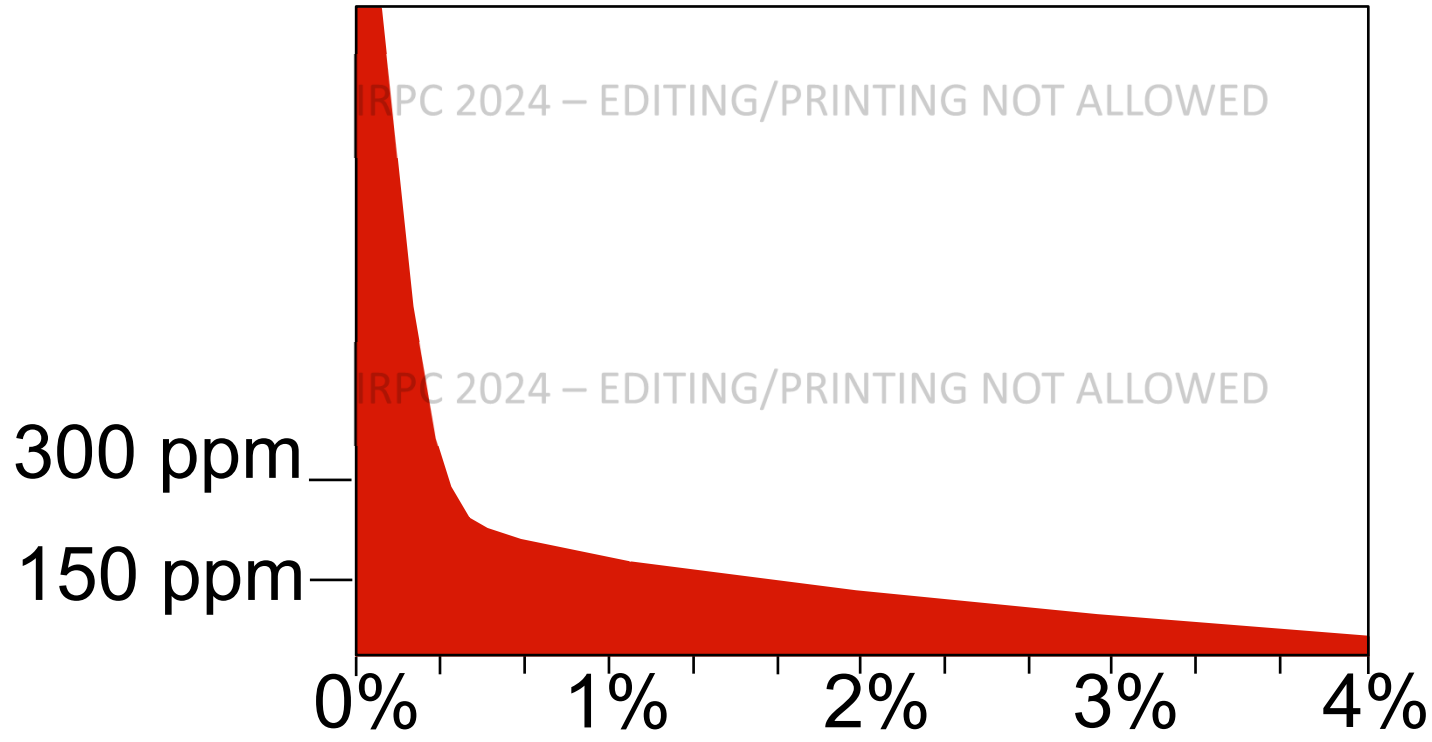
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The challenge: What is safe & efficient?



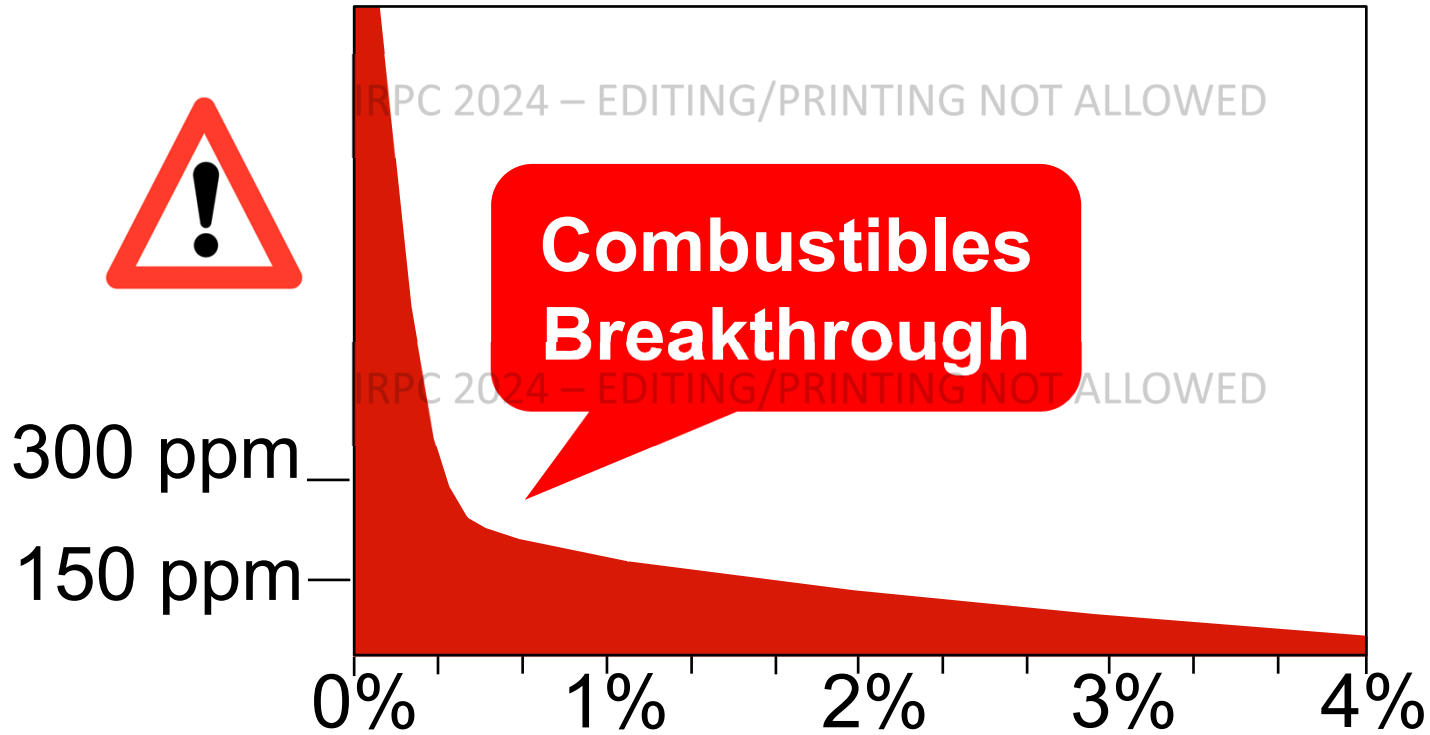
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Combustibles decrease with excess air



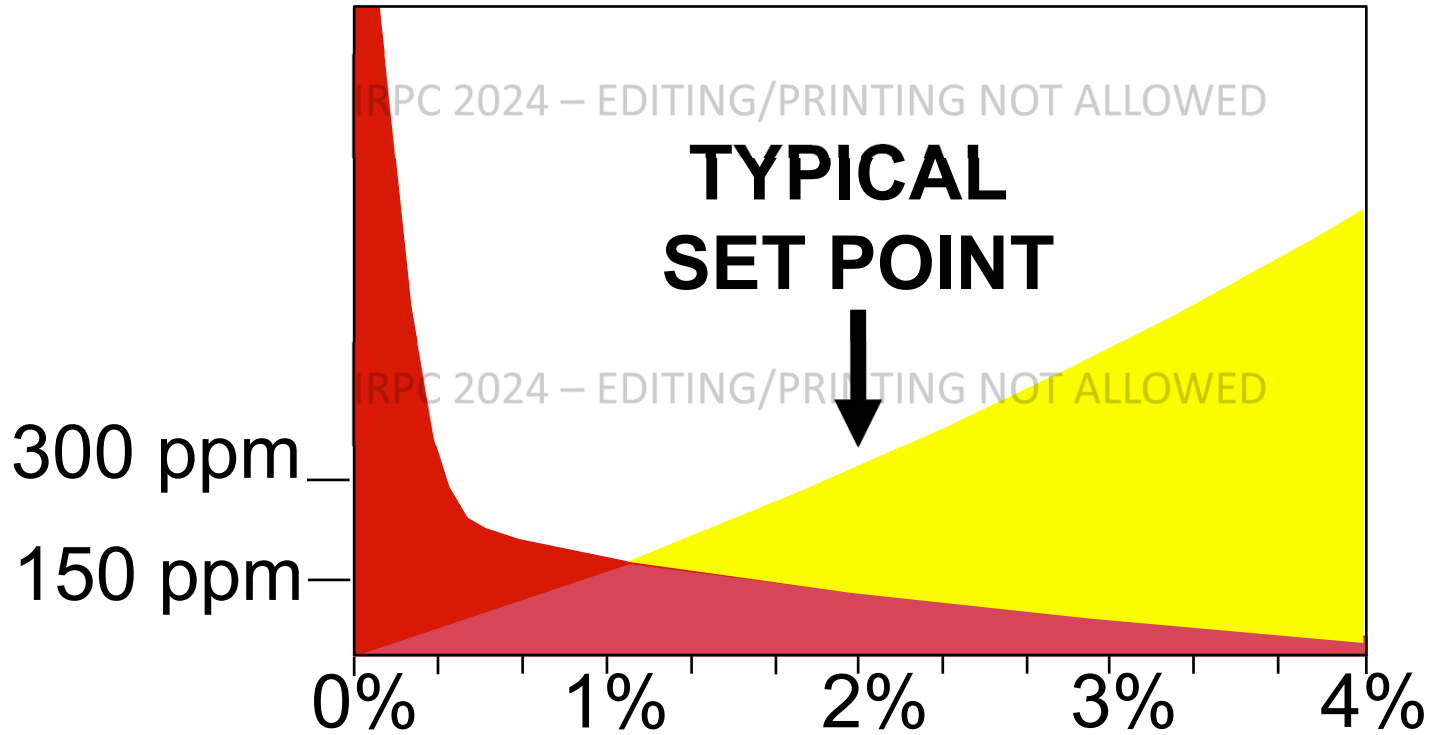
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Combustibles spike when O₂ is too low



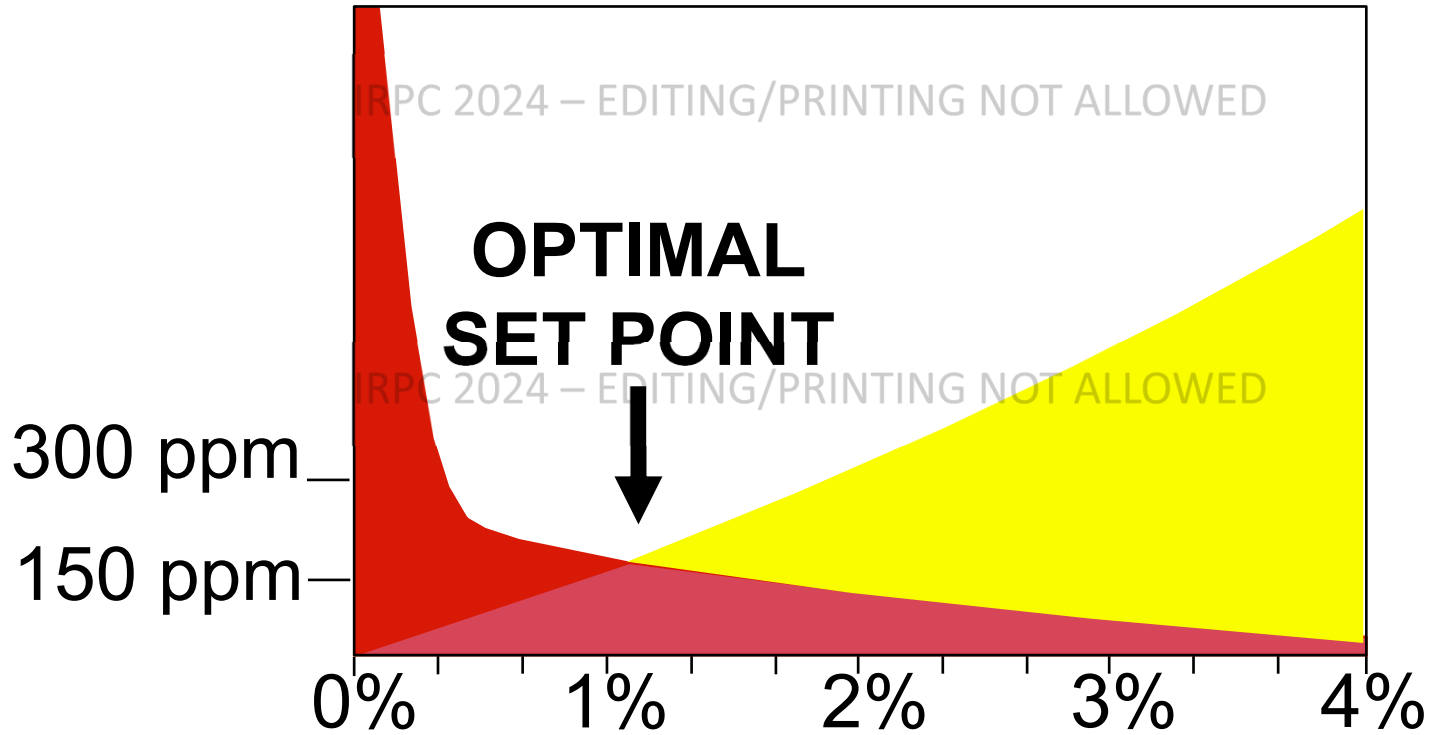
(For illustrative purposes only)

Optimal Combustion depends on both



(For illustrative purposes only)

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Optimize with **excess O₂** & **combustibles**

Excess

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Air

Fuel



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CO₂

H₂O

ppm H₂

ppm CO



Excess O₂

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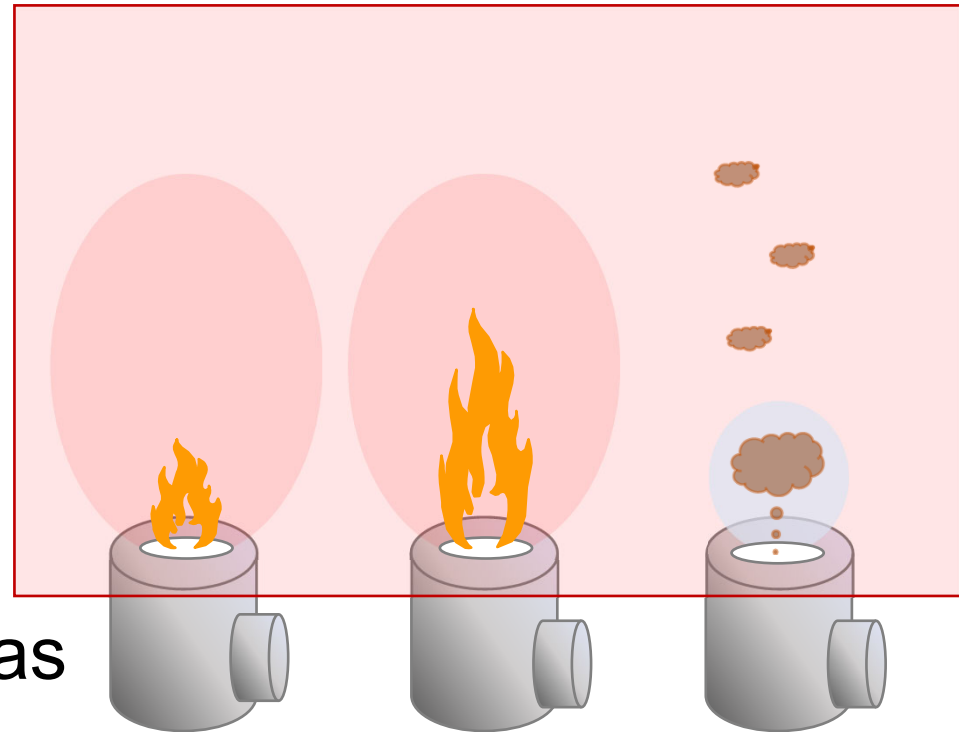
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Increasing Safety During Start-up & Process Upset

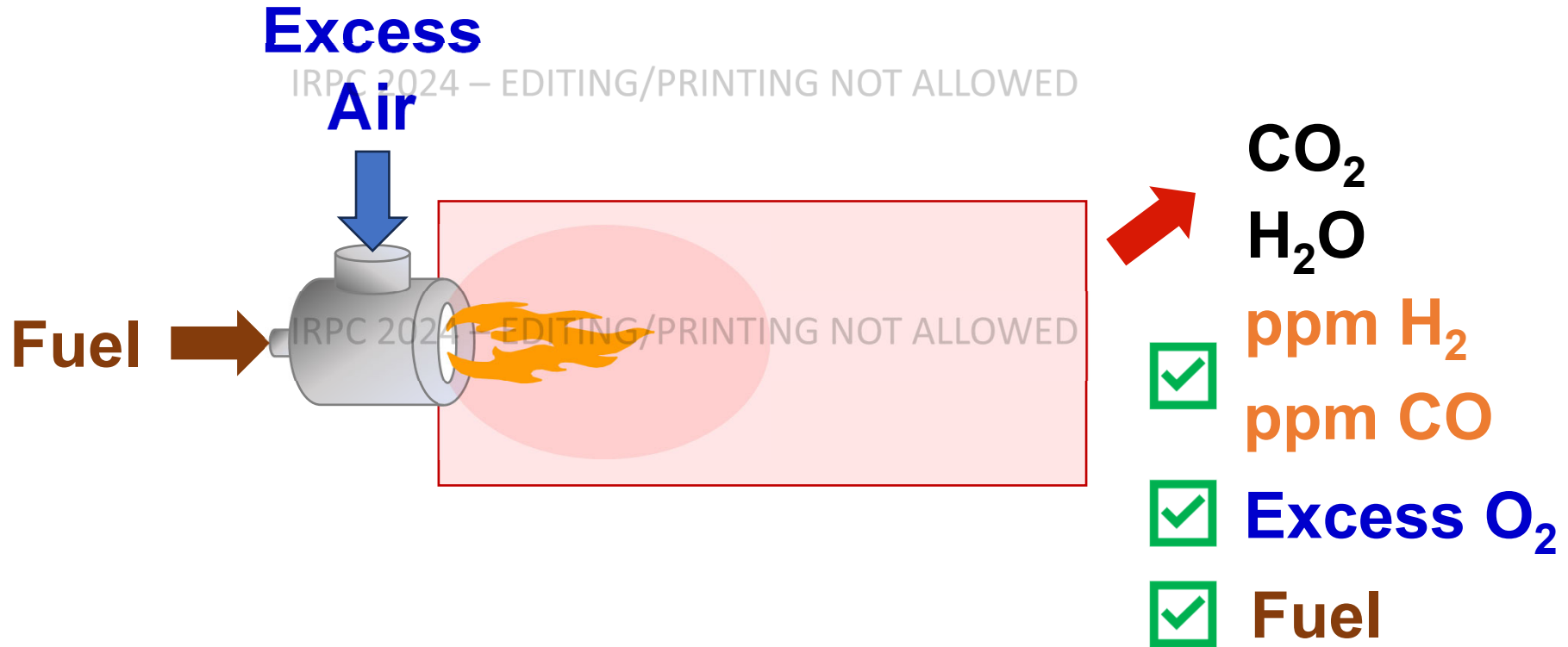
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Increasing Safety during Startup & Upset

- Monitor for:
 - Loss of flame
 - Leaking burners
 - Fuel-rich conditions
- Monitor for fuel accumulation in flue gas



Three Critical Flue Gas Measurements



Key Takeaways

- **Excess O₂** provides an operating setpoint, correlating air-fuel ratio and safety margin at burner
- **Combustibles** provides a secondary measurement to optimize excess air & reduce CO₂, NOx, & fuel
- **Hydrocarbon / methane** measurement in flue gas provides greater visibility during Startup & Upset

A photograph of an industrial refinery at night, featuring a complex network of pipes, towers, and scaffolding. The scene is overlaid with a semi-transparent red filter. A large, stylized graphic consisting of several overlapping, wavy bands in shades of blue, orange, and red is positioned at the top of the image. The word "Questions?" is written in a large, white, sans-serif font across the center of the image.

Questions?



Thank you!