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Why won’t my burner light-off?

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Why won’t my burner light-off? Overview

- Review of a typical light-off sequence and flame safeguard behavior
- Understanding the combustion triangle and how it affects the reliability of your burner performance.
- How faulty flame detection can cause light-off issues.
- Where to look beyond the burner and flame detector for other causes of light-off failure.
- How to perform a pilot turn-down test for more reliable performance.

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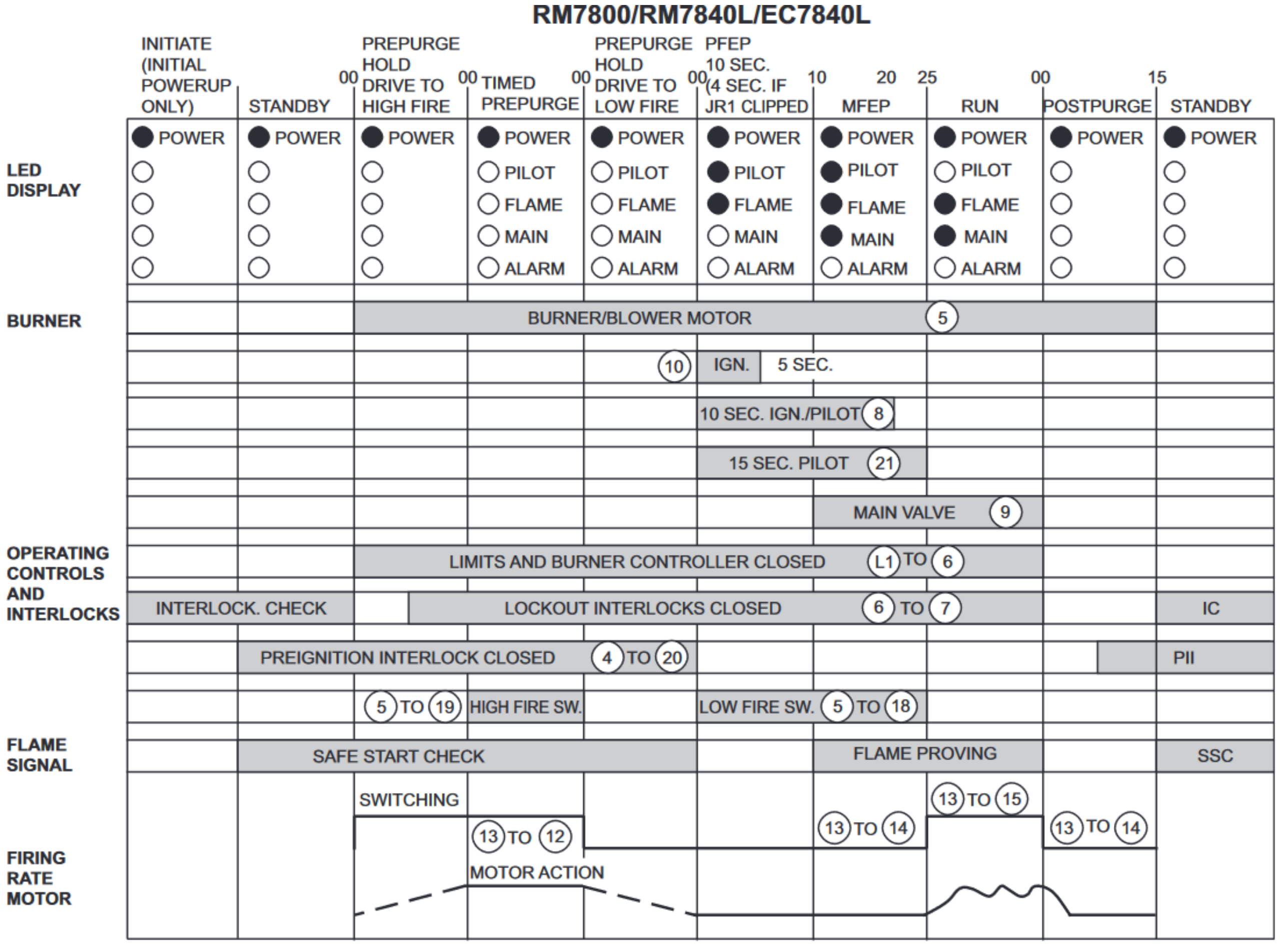
Typical Light-Off Sequence

- Initiate
- Standby
- Safe-Start Check
- Preignition Purge Sequence
- Pilot Flame Establishment Period
- Main Flame Establishment Period
- Run/Modulate Enable



Initiate

- Initiate is the first step in the light-off sequence, happens as soon as power is applied to the flame safeguard.
- Flame Safeguard goes through internal checklist to make sure that:
  - Voltage within tolerance (typically + or – 10 to 15% of rated voltage)
  - Frequency within tolerance (typically + or – 10% of rated frequency)
  - Internal circuits are functioning properly
    - Flame Amplifier/Purge Card is correct type for application
    - Configuration Switches/Jumpers in valid positions
- If the flame safeguard detects abnormal voltage or frequency, it will either go immediately into a lockout condition or go to a hold condition to give you time to correct.

Stuck in Initiate?

- If you are stuck in the initiate step in the light-off sequence, you'll want to:
  - Verify the line voltage/frequency going into the flame safeguard
  - Verify compatibility of components if they were recently replaced
- Try installing a keyboard display
  - Provides diagnostic information including fault codes and terminal status

Standby

- After initiate, the flame safeguard goes into standby, awaiting a call for heat to begin the ignition sequence.
- In order to being the light-off sequence, the following conditions must be met:
  - All internal circuits are functioning properly
  - Interlocks are satisfied
  - Call for heat permissive is recognized
- If one of the above conditions are not met, the flame safeguard will stay in the standby state, and may not create a lockout condition.

Stuck in Standby?

- If you are stuck in the standby step in the light-off sequence, you'll want to:
  - Verify voltage at the interlock terminal
    - Make sure to check manual reset devices
  - Verify voltage at the call for heat terminal
- Try installing an expanded annunciator
  - Keeps track of interlock string by detecting voltage between each device
  - Added benefit of recording "First Out"
  - Can program custom labels via keyboard display

Safe-Start Check

- Safe-Start Check is the first step in the ignition sequence after the flame safeguard receives the call for heat.
- Occurs before and during the preignition purge sequence.
- Safe-Start Check is like the initiate step, where internal checks are done to confirm the flame safeguard is functioning properly.
- Getting stuck here usually means a faulty flame safeguard.

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Preignition Purge Sequence

- Depending on the model of flame safeguard, the next step is to go through the preignition purge sequence.
- Flame safeguard commands actuators/dampers to high fire/max airflow condition to remove any potential combustible gases from the combustion chamber.
  - NFPA 86 Section 8.5.1.2.1 requires four volume changes of fresh air:

$$Prepurge\ (min) = \frac{4 \times Combustion\ Chamber\ Volume\ (ft^3)}{Exhaust\ Airflow\ Rate\ (ft^3/min)}$$

- Purge conditions must be met during the entire preignition purge sequence, if they aren’t maintained the flame safeguard will either reset (start preignition sequence again) or lockout.
- Upon completion of the preignition purge, the flame safeguard commands the actuators/dampers to the light-off positions.

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Stuck in Preignition Purge Sequence

- If you are stuck in the preignition purge sequence step in the light-off sequence, you'll want to:
  - Verify wiring between flame safeguard and actuator
    - Position Command – Flame Safeguard to Actuator
    - Position Feedback – Actuator to Flame Safeguard
  - Make sure interlocks are remaining on throughout the entire preignition purge sequence
- **TIP: Consider external position switches for preignition position proving**
  - In the case of a mechanically-linked system with position switches internal to the actuator, a broken or disconnected linkage arm could verify purge positions are met while the air control valve is at a low flow condition. A switch installed on the air valve that only makes when the valve is fully open provides an extra level of safety.

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Pilot Flame Establishment Period

- The most critical step in the light-off sequence, where most light-off failures occur.
- Depending on the model of flame safeguard, you will have either 10 or 15 seconds to prove the pilot flame before you can advance to the main flame establishment period.
- Failures in this step can be lumped together into two categories:
  - Failure to **establish** a pilot flame
  - Failure to **detect** a pilot flame

Failure to Establish a Pilot Flame

- During the pilot flame establishment period, we are introducing pilot gas (fuel) and energizing an ignition transformer (heat) to the pilot/combustion air (oxygen) to complete the combustion triangle.

- In order for combustion to occur, we not only need all three of these elements, but we need the proper **ratio** of oxygen to fuel as well.

Failure to Establish a Pilot Flame (cont.)

- All burners are different with respect to how they mix their pilot gas and air, so it is critical to understand the flow and pressure requirements of that burner's pilot from the manufacturer.

OVENPAK® LE 10 burner

Typical burner data Fuel: natural gas at 60°F with 1000 Btu/ft³ HHV - sg = 0.6 [1] Combustion air: 60°F - 21% O_2 - 50% rel. humidity - sg = 1.0 [1] Stated pressures are indicative. Actual pressures are a function of air humidity, altitude, type of fuel, and gas quality.		
Maximum capacity [2]	Btu/h	1,000,000
Minimum capacity [3]	Btu/h	30,000
Maximum turndown		33:1
High fire gas pressure differential [4]	"wc	8.1
Combustion air pressure differential	"wc	8.1
Combustion air volume [6]	cfm	263
Fan motorpower	hp	1
Pilot capacity [5]	Btu/h	20,000
Approximate inlet gas pressure required	"wc	10.5

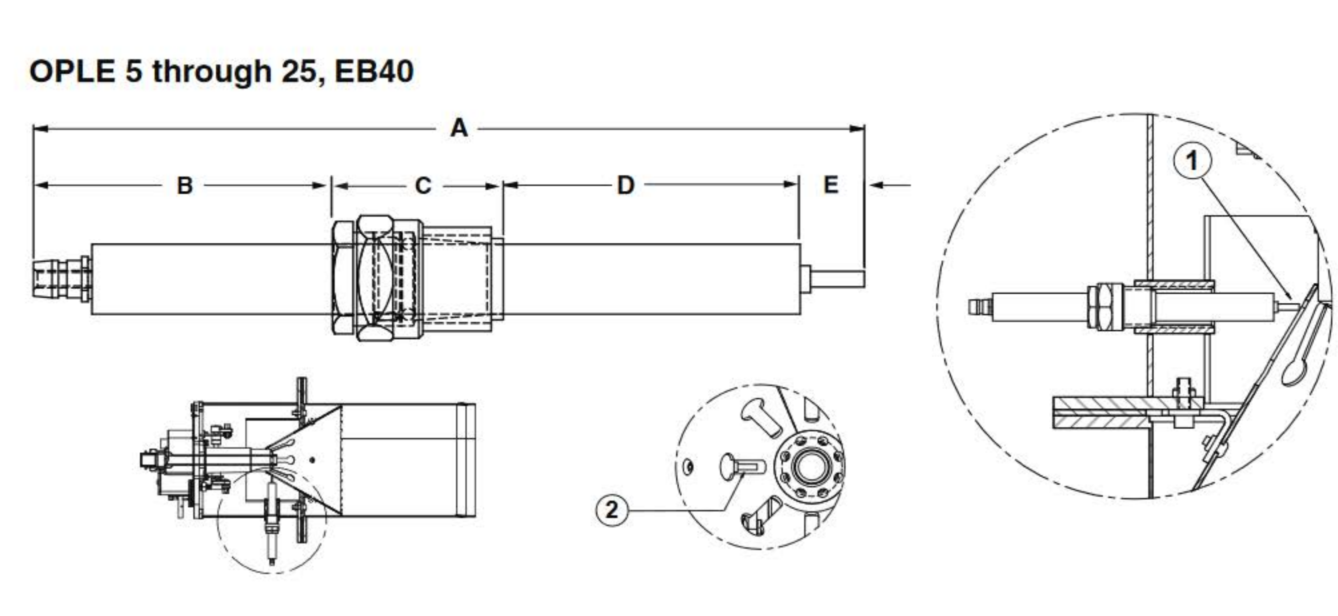
[1] sg (specific gravity) = relative density to air (density air =0.0763 lb/ft³(st))
[2] Capacity displayed assumes blower operation on 60Hz electrical supply. Gross output will be reduced by 17% if operated on 50Hz. Fuel and air pressures should be reduced by 30% while motorpower will reduce 40% with 50Hz operation.
[3] Minimum capacity may be affected by fuel and application parameters.
[4] Gas pressure displayed for natural gas or propane. Propane pressures shown require use of optional propane nozzle.
[5] Pilot gas pressure at adjustable gas orifice should be 4-8" wc .
[6] Combustion air defined at standard temperature and pressure.

Failure to Establish a Pilot Flame (cont.)

- In addition to having the correct pilot gas and air pressure, the location of the spark ignitor is also critical to establishing a pilot flame. Again, consult the burner manufacturer for proper spark ignitor placement.

Spark ignitors

1) Set spark ignitor flush with outside of mixing cone
2) Spark ignitor



Failure to Establish a Pilot Flame (cont.)

- Pilot Turndown test – Available on some models of Flame Safeguards
- Allows operator to extend the Pilot Flame Establishment Period to adjust the pilot flame without nuisance safety shutdowns.
- Typically adjusting pilot gas only via an orifice valve or regulator.
- Looking to create reliable and repeatable pilot flame, doesn't need to have same signal strength as main flame.

(Size of tennis ball for most Maxon burners)

Failure to Establish a Pilot Flame (cont.)

- Common sources of pilot establishment failures include:
  - Too much combustion air – blows out pilot flame like a candle
  - Too little pilot gas flow. Same as above, we need the right air/fuel ratio
    - Pilot lines are typically smaller in size and could collect debris in the orifice valve, blocking the flow of pilot gas. A quick fix here would be to remove the orifice and blow the line out if you suspect that the pilot gas flow is inadequate.
  - Pilot gas takes too long to get to the burner assembly
    - Consider relocating and/or installing pilot solenoid valves closer to the burner inlet.
  - System backpressure restricting flow of pilot gas
    - Increase pilot gas pressure and/or adjust orifice valve
  - Spark Ignitor failure
    - Soot build-up
    - Sparking at base instead of tip

Failure to Establish a Pilot Flame (cont.)

- Seeing is believing! Having a sight port looking into the burner's pilot mixing zone will allow you to distinguish a failure to establish a pilot flame versus failure to detect a pilot flame, in case the flame safeguard still cannot detect a flame.
- Some burners have sight ports built into the burner body, but you may want to consider adding a sight port in the chamber opposite of the burner looking back in so you can see the pilot flame.
- Different types of flame detection have different criteria for verifying presence of flame. Just because you can see the flame doesn't mean the detector will see the flame.

Types of Flame Detection

- Flame Rods
  - Uses the principal of flame ionization to pass a current through the flame to verify its presence.
  - Requires proper grounding to work efficiently.
  - Not applicable for all burner designs/operating conditions
- Scanners
  - Photo-eyes are used to detect different spectrums of light energy from a flame to verify its presence.
    - Ultra-Violet – common with natural gas/propane burner applications
    - Infra-Red – common with coal, oil, and manufactured gases

Types of Flame Detection (cont.)

- Like spark ignitors, flame rods need to be positioned properly per the burner manufacturer's recommendations for the most reliable performance.
- Scanners also need to be positioned properly and have a straight line of sight to the pilot flame zone.
- Scanners can sometimes pick up a false signal, and a common occurrence during the pilot flame establishment period is called "spark excitation", where the scanner detects the spark instead of the flame.
- Good burner design and proper spark ignitor installation should shield the spark from the sight path of the scanner.
- Honeywell makes a half-wave ignition transformer that sparks out of sync with the UV scanner's detection cycle, avoiding spark excitation even if the spark is in the sight line of the scanner.

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Failure to Detect a Pilot Flame

- Common sources of pilot flame detection failures include:
  - Flame Rod not grounded or improperly grounded
    - Current needs to complete a path from the flame safeguard, to the flame rod, through the flame, into the burner body/ground, and back to the panel’s ground.
  - Dirty scanner lens
    - Dirt and debris from the combustion chamber could accumulate on the lens of the scanner.
  - Flame size too small to be detected
  - Flame stays on with ignitor, goes out when ignitor turns off
    - Typically needs more pilot gas flow to stabilize
  - Flame has weak UV/IR signature for the type of scanner being used
    - Adjust pilot gas pressure to increase that component in the flame signature
  - Signal interference from ignition transformer or other background noise

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Failure to Detect a Pilot Flame (cont.)

- **TIPS for improved flame signal strength**
  - For flame rod applications, consider trying "Extended Distance" Flame Amplifiers
    - Available for most Honeywell RM7800 series flame safeguards
    - Increased sensitivity provides greater flame signal when flame detected
  - For UV Scanner applications, bring purge air into the sight pipe
    - Prevents scanner lens from building up with dirt/debris from combustion chamber
    - Also keep chamber heat away from the scanner
  - Consider upgrading your UV scanner and flame amplifier
    - Honeywell C7061 scanners provide a much better flame strength compared to the C7012 scanners at a much lower price point.
    - Would also need to replace the flame amp card to an R7861

Main Flame Establishment Period

- Now that the pilot flame has been detected, the flame safeguard will attempt to establish main flame.
- Similar to the pilot flame, the correct amount of air and fuel need to be delivered to the burner to achieve main flame.
- New to NFPA 86 – Section 8.10.6 states that:

"A line burner, pipe burner, or radiant burner with flame propagating 3 feet or longer shall have at least one flame detector installed to sense burner flame at the end of the assembly farthest from the source of ignition."

- Typically these line burners are constant air/variable fuel, and initial light-off conditions may require additional gas flow above the minimum capacity to achieve repeatable and reliable flame propagation. Consult the burner manufacturer to verify capacity ranges for light-off.

Failure to Transition to Main Flame

- Sometimes after the main flame establishment period is completed and the pilot flame turns off, the flame safeguard shuts the system down.
- This is common if the main gas flow is inadequate or takes too long to get to the burner.
- This can also happen if the pilot gas flame is not large enough to reach the mixing zone of the main gas supply and main flame area. There needs to be an intersection of these two flame zones to complete the sequence.

Run/Modulate Enable

- You’ve completed the light-off sequence and you can now throttle the burner as desired. Congratulations!
- If you are having problems staying running, you may be interested in joining me for my follow-up webinar:

Why does my burner keep shutting down?

Thursday, March 26th at 9am Central

www.lesman.com/train

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Any Questions?

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