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Why does this Burner have this type of Flame Sensor?

Primary Safety input into a BMS or FSG..

#1 Flame presence or absence

A safety system is only as safe as its least safe element

author unknown, but she's correct

The absence or presence of Flame

The Flame Monitor/Sensor/Detectors/Scanner/Viewing Heads all serve the same purpose

"To Provide intelligence" to the Logic Solver / Burner Management Systems

Failure to detect the **presence of a flame**; may result in an explosion with any fuel leakage

Flame detected when **no flame** is present in furnace; as a result, the Fuel Valves may remain open with no local source of ignition resulting in fuel rich furnace and subsequent explosion

Is it because of the Fuel and Burner Design ?

Pre-Mix burners are usually capable of creating a target zone with sufficient UV radiation

The overall quantity of UV radiation typically pales to the amount of useful IR emittance ; thus,
Infrared flame sensors “could” be used on vapor (gas) or liquid or solid fuel applications

Extreme caution should be exercised when applying Visible Light and IR flame sensors to a BMS

The Fuel and Oxygen mix in the target(able) zone may dictate the best means of monitoring

Fuel vs Flame “Color” vs Temp

Gas flames are normally blue, but sometimes they burn red or yellow when there is a problem.

For natural gas (methane); when the flame color is blue the flame temperature is about 1,960°C

Organic/Carbon Based Flame Color

- Dark red (first visible glow): 500 to 600 °C (900 to 1,100°F)
- Dull red: 600 to 800 °C (1,100 to 1,650°F)
- Bright cherry red: 800 to 1,000 °C (1,650 to 1,800°F)
- Orange: 1,000 to 1,200 °C (1,800 to 2,100°F)
- Bright yellow: 1,200 to 1,400 °C (2,100 to 2,500°F)
- White: 1,400°C (2,500 to 2,900°F)
- Blue: >1600°C (2,600 to 3,000° F

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Installation Factors & Common considerations

1. Type of fuel (CH4, C3H4, CO, etc)
2. Specific fuel
3. Distance between UV detector and flame.
4. Area of detector's flame sighting aperture.
5. Ambient temperature.
6. Presence of unburned fuel.
7. Presence of vapors which strongly absorb UV radiation.

UV Sensors

Common Models and spectral response

HONEYWELL	
C7012*	185 to 255 nanometers (10^{-9} meters)
C7027/C7035/C/M7061*	185 to 245 nm
C7076*	185 to 270 nm
C7927/C7961	200 to 390 nm Solid State Visible Light
S706/S806*	185 to 260 nm
U2-1016S/S556*	190-215 nm
FIREYE	
45UV5/UV1AL/UV90L/48PT2	190-250 nm
55UV5/65UV5	220-260 nm
95UV	295-320 nm

IR Sensors

HONEYWELL	
U2-1012S/S552BE	1,100-3,000 nm
C7915 Lead Sulfide	750-1,000 nm
C7962 Visible Light	
FIREYE	
95IR	700-1,700 nm

Is it because of a NFPA or ASME Safety Standards?

The most common Safety Standards and Recommended Best Practices

NFPA 85 Boiler and Combustion Systems Hazards Code

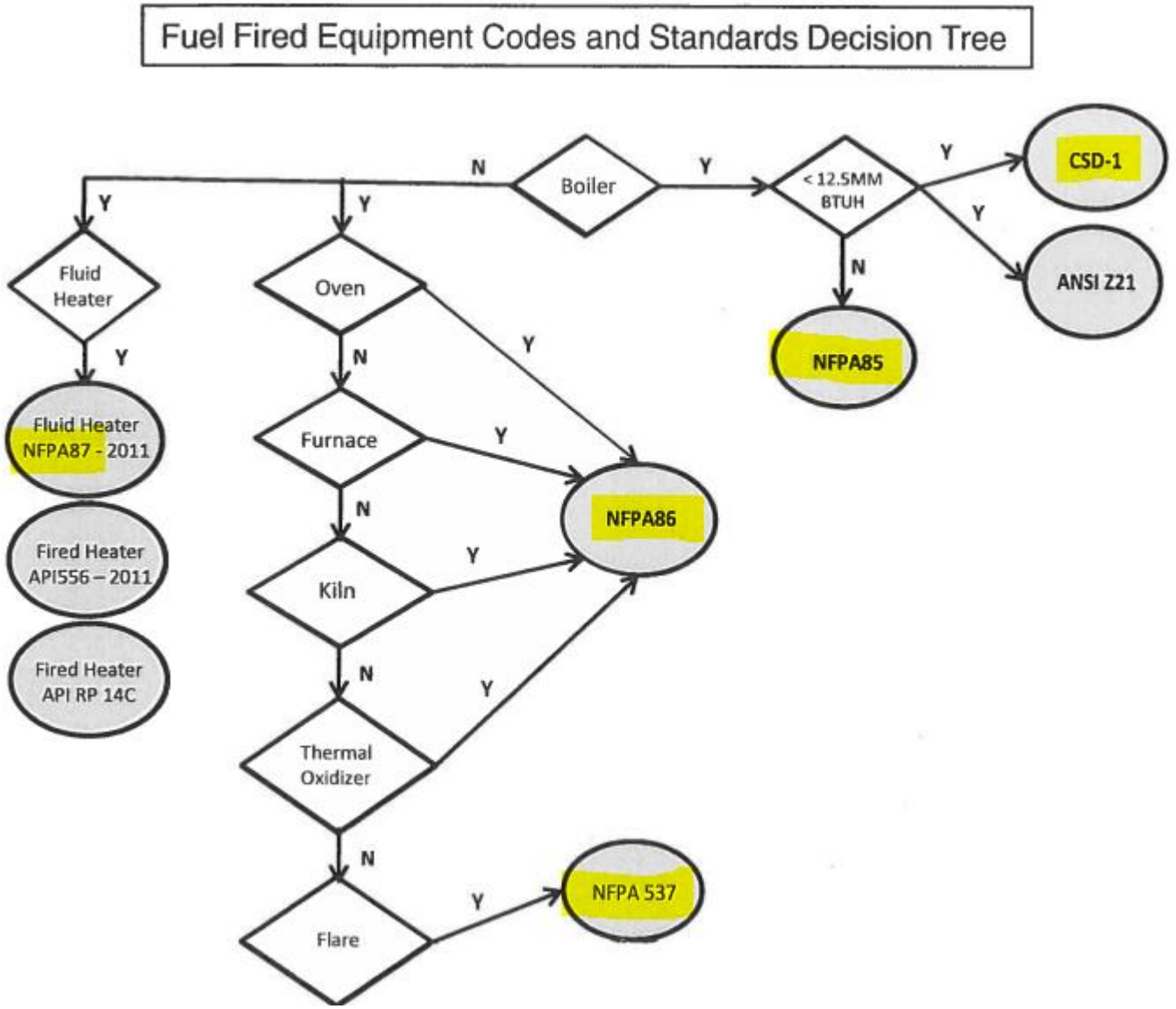
NFPA 86 Standard for Ovens and Furnaces

NFPA 87 Recommend Practice for Fluid Heaters

CSD-1 Controls and Safety Devices for Automatically Fired Boilers

American Petroleum Institute (API)

Which standard applies



NFPA 85

3.3.56.1 Self-Checking Flame Detector. A flame detector that automatically, and at regular intervals, tests the entire sensing and signal processing system of the flame detector.

Annex C Multiple Burner Boiler Low NOx Operation – Special Considerations 4) In-furnace NOx control technologies that utilize staged fuel injection could result in combustion conditions that are not detectable with existing flame detector technology.

A.7.10.2.2 (4) Flame detector trouble. This alarm warns the operator of a flame detector malfunction.

A.6.4.2.1 Monitors of furnace conditions include the following:

(1) Furnace television. A properly designed and installed furnace television can be of significant value as a supplementary indication of flame and other conditions in some furnace designs. It is of particular value during start-up in viewing igniters and individual burners for proper ignition. This is an aid to, **but not a substitute for**, visual inspection.

(2) Flame detector indication. This television monitor provides a means for operator observation of flame detector output signal strength.

NFPA 86

3.3.62* Safe-Start Check. A test incorporated in a combustion safeguard that prevents start-up if a flame-detected condition exists due to component failure within the combustion safeguard or flame detector(s) due to the presence of actual or simulated flame.

8.5.2.3 Where direct spark ignition systems cause a false flame signal in required flame detectors and combustion safeguards, the electrical spark shall be terminated after the main burner trial-for-ignition period.

8.10 Flame Supervision.
8.10.1* Each burner shall have a supervised flame monitored by a flame detector and combustion safeguard that are interlocked into the burner management system unless otherwise permitted in 8.10.2.

8.10.6* Line burners, pipe burners, and radiant burners, where installed adjacent to one another or connected with flame-propagating devices, shall be considered to be a single burner and shall have at least one flame detector installed to sense burner flame at the end of the assembly farthest from the source of ignition

A.8.10.1 Subsections 8.2.2 and 8.2.5 require that the flame detector and the combustion safeguard be applied and installed according to the manufacturer's instructions. Where flame detectors (scanners) with combustion safeguards continuously operate without a shutdown beyond the maximum interval recommended by the combustion safeguard and flame detector manufacturer's instructions, such continuous operation without a shutdown and safe-start check would not be compliant. Ultraviolet sensors can fail in such a manner that the loss of flame is not detected. Where these sensors are placed in continuous service, failures can be detected by a self-checking ultraviolet detector or by periodic testing of the detector for proper operation.

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NFPA 87

A.8.9.2 Ultraviolet detectors can fail in such a manner that the loss of flame is not detected. When these detectors are placed in continuous service, failures can be detected by use of a self-checking ultraviolet detector or by periodic testing of the detector for proper operation. Flame detectors (scanners) with combustion safeguards that continuously operate beyond the maximum interval recommended by the combustion safeguard and flame detector manufacturer's instructions would not be compliant.

CSD-1 ASME

ASME SAFETY STANDARD #CSD-1 CONTROLS & SAFETY DEVICES GUIDELINES FOR AUTOMATICALLY GAS FUEL FIRED BOILERS				POWER & MECHANICAL DRAFT BURNERS Input in Btu/h				ATMOSPHERIC (NATURAL DRAFT) BURNERS Input in Btu/h				Associated Standard Paragraph
INSTALLED	NOT INSTALLED	NOT REQUIRED	SYSTEM CONTROL SPECIFICATIONS	Less than 400,000 (Including Modular Boilers with maximum inputs of 400,000 per module)	400,000 to 2,500,000	2,500,000 to 5,000,000	5,000,000 to 12,500,000	Less than 400,000 (Including Modular Boilers with maximum inputs of 400,000 per module)	400,000 to 2,500,000	2,500,000 to 5,000,000	5,000,000 to 12,500,000	
			Supervise Main Flame	(34)	Required	Required	Required	(34)	(34)	(33)	Required	CF-310 (d) (1) (2) (3) (4)
			Flame Failure Response Time (FFRT)	4 Sec Max (36)	4 Sec Max	4 Sec Max	4 Sec Max	4 Sec Max (35) (36)	4 Sec Max	4 Sec Max	4 Sec Max	Tables CF-1, CF-2, CF-4
			Action of Flame Failure	Safety Shutdown (37) (38)	Safety Shutdown (39)	Safety Shutdown	Safety Shutdown	Safety Shutdown (37) (38)	Safety Shutdown (40)	Safety Shutdown (40)	Safety Shutdown (40)	Tables CF-1, CF-2, CF-4
			Action on Limit Opening	Safety Shutdown	Safety Shutdown	Safety Shutdown	Safety Shutdown	Safety Shutdown	Safety Shutdown	Safety Shutdown	Safety Shutdown	CF-162 (a), CF220 (a), CW-130 (d), CW-310 (c), CW-410 (c), CF-910

THIS FORM IS A SURVEY SHEET AND IS NOT PART OF ASME CSD-1

64-0054-2

(33) Required with modulating or high-low firing.

(34) Required if interrupted pilot.

American Petroleum Institute – RP and Standards

RP 534 (HRSG)
RP 535 (Fired Heaters)
RP 538 Industrial Boilers
RP 556 Instrumentation, Control, and Protective Systems for Fired Heaters
Standard 537 (Flare),
Standard 560 Fired Heaters

Example from RP556:
Flame rods are considered consumable and require periodic replacement. The flame ionization rod is only used to detect the pilot flame, as it is not suitable for long-term use in the main flame.

RP 556P 556 Instrumentation, Control, and Protective Systems for Gas Fired Heaters Provides guidelines that specifically apply to instrument, control, and protective system installations for gas fired heaters in petroleum production, refineries, petrochemical, and chemical plants. Includes primary measuring and actuating instruments, controls, alarms, and protective systems as they apply to fired heaters. **Not covered** in this RP are the following: oil fired and combination fired heaters; water tube boilers which consist of single or multiple burners and are designed for utility operation or where the primary purpose is steam generation; fired steam generators used to recover heat from combustion turbines; oven and furnaces used for the primary purpose of incineration, oxidation, reduction, or destruction of the process medium; water bath or oil bath indirect fired heaters; and CO boilers, pyrolysis furnaces, and other specialty heaters.

Is it because of the Type of Logic Solver or Flame Relay in Use?

Common Logic Solvers used for Combustion Safety:

1. Flame Safeguards – Safety Controller that ensures the safe and reliable start-up, Monitoring and shutdown of a fired asset… “Fixed”
2. Programmable Logic Solver – General Purpose and Safety PLCs are commonly programmed for Burner Management applications
3. “Tug” the ex-Navy Boiler Operator (365/24/7 Supervised Boiler)

Flame Safeguard

1. Commonly referred as Plug'n Play; as they are often modular and configured for specific functionality
2. FSG are produced by many manufactures with different Sensing Options: (most common)
    a. UV tube Non-Checking
    b. UV tube Self-Checking
    c. Solid State UV (photo cell)
    d. Solid State Infrared
    e. Flame Rod
3. FSG systems are typically only compatible with the same brand of Flame Sensors
4. Most common variants
    a. Primary
    b. Programmer

Two PLC Logic Solver examples

1. Hybrid – GP PLC handling Non-Safety Checks and some Permissives
    a. Integrated with Flame Safeguard
    b. Limited design liability
    c. Able to Utilize standard Flame Safeguard Flame Sensing options
2. Safety PLC used for both Flame Safeguard and Process functions
    a. Expanded flexibility
    b. High Design Liability
    c. Ability to Use advanced Flame Monitors (exotic fuels, flame discrimination, +)

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Supervised system

Rick makes decisions & operational adjustments based on Data from; Field Instruments, Demand requirements, Fuels available, Weather, etc.. While some “Automated functions may exist”; Rick’s acting as the Safety System..

A supervised system will most often get outfitted with Advanced Flame Monitors/Switches; why..?

1. Many supervised systems are multifuel capable (i.e. Nat Gas Primary with an Oil or Coal alternate)
2. Multi-burner flame envelope discrimination (burner to burner or just level to level)
3. Additional data (i.e. Discrete, Analog, and often ModBus communications)

Questions ?

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