Combustion safety control systems for boilers and ovens

Heating equipment can be found in all businesses and industries. Boilers, heaters, ovens, kilns or process furnaces can simply provide heat to a building or they can be a key element in the manufacturing process. Because most heating systems operate automatically, you need to rely on control and safety devices to ensure a safe start-up and shut-down procedure.

According to one leading property insurance company, over the past 15 years, more than 150 combustion explosions have been reported. These losses represented $259 million, and in most cases, the underlying cause was failed or missing safety devices.

- Does your facility rely on a fuel fired appliance (boiler, oven, etc.) for production processes or building services?
- Are you aware that jurisdictional inspectors may not normally complete a comprehensive review of combustion controls nor do they commonly leak-test safety shut-off valves?
- Are the safety shut-off valves leak-tested annually?
- Does the boiler or oven meet current local or provincial code requirements as it relates to combustion safety interlocks?
- Are the boilers or ovens listed by a nationally recognized testing laboratory agency?

After answering these questions you may discover that a boiler or oven may not be getting the proper attention that it needs to provide uninterrupted service to your facility. More importantly, it could be putting your facility at risk for an interruption in production, or worse, a severe explosion.

When it comes to boilers, it is a common misconception that boiler inspectors complete leak-testing of safety shut-off valves and a review of combustion controls during regular inspections. In reality, jurisdictional inspectors often only concentrate on the pressure side of the system, and can only evaluate equipment for its code compliance according to the active code at the date of installation. Recent losses have shown that even the smallest fuel fired appliance can catastrophically explode causing severe property damage with subsequent fatalities.

Process ovens can also be a source of a severe loss when they are not installed, operated, tested or maintained according to the latest combustion safety guidelines. The potential for a catastrophic incident exists not only during start-up, but also during regular operation and when the equipment is idle. Adequate combustion safety controls can help to ensure that the entire process is safely controlled.

Although older equipment may have met certain codes/standards at the time of installation, it may offer only minimal protection of property and life safety. The following principles may improve overall risk control when installing new equipment, upgrading old equipment, or completing a review of current appliances:

- Install equipment that is listed by a nationally recognized testing laboratory agency such as Underwriters Laboratories (UL), Underwriters Laboratories of Canada (ULC), Factory Mutual (FM Global), American Gas Association (AGA), International Approval Services (IAS), Canadian Gas Association (CGA), ETL Testing Laboratories, NV Kema, Sira, Vds Gastec.
- Verify that your current installation meets or exceeds combustion control guidelines consistent with the type of equipment present and in accordance with an applicable code/standard: National Fire Protection Association (NFPA), ASME-CSD1 (Controls and Safety Devices for Automatically Fired Boilers), Factory Mutual (FM Global), Underwriters Laboratories, ANSI, IAS (CGA/AGA).
- Implement a program for inspection, testing, and maintenance of equipment at intervals consistent with the type of equipment used, service requirements and manufacturers' recommendations.
- Verify that operators and supervisors are instructed and trained under the direction of qualified personnel. Operators should demonstrate understanding of equipment and practise safe operating procedures.

Key components

Delivering fuel to the combustion chamber in the correct proportions for efficient and safe burning is the main goal of a fuel control system.

The combustion safeguard system is usually an electronic box located near the combustion chamber. It is the "brains" of the fuel control system and is fed control data by the components listed below.

Fuel is usually fed to the heating system through a gas or fuel train, which is a piped supply that contains a series of safety and control devices.

Key components in the fuel train are as follows:

- **Regulator:** Fuel pressure is usually well above that required by the heating system. A regulator is located at the beginning of the fuel train. The desired operating pressure is set and the regulator automatically opens or closes to maintain that pressure regardless of flow rate.
- **Low pressure switch:** This switch monitors gas pressure at the source. If the pressure falls below a pre-determined setting, perhaps due to a leak, the low-pressure switch shuts down the entire system. These switches are usually required to be manually reset which will help make the operator aware of what caused it to operate. The low-pressure switch is usually located before the Safety Shut-off Valve.
- **Safety shut-off valve (SSOV):** The SSOV is both a control valve and a safety device. As a control valve, it opens and closes to start and stop the fuel flow. As a safety device, it shuts down fuel flow if a monitored device, such as a low-pressure switch, goes out of range.
- **High pressure switch:** This switch operates like a low-pressure switch. If the regulator fails and pressure increases above the pre-determined setting, the high-pressure switch instructs the SSOV to shut down the fuel flow.
- **Modulating valve:** This valve controls the quantity of fuel entering the combustion chamber based on the control system demand. As a safety feature at start-up, there is a low fire switch, which ensures fuel flow is at a minimum during startup.
- **Combustion air fan:** To burn fuel efficiently and safely, air is needed in proportional amounts as the fuel is being introduced into the combustion chamber. Additional air is also required to help combustion gases make it up the exhaust stack. Dampers, fan speed or both can regulate airflow. The combustion safeguard system monitors airflow so it can shut down the fuel flow in the event of lost air. Usually, there is also an exhaust gas temperature switch monitoring exhaust temperature. If the temperature varies beyond a pre-set range, the system shuts down.

- **Low water cutoff:** In boilers, if the water level is too low and combustion continues, the metal tubes inside the boiler will overheat and collapse. A low water cutoff will sense a low water condition and shut down the system.
- **Purge timer:** At start-up, it is necessary to purge the combustion chamber of all unburned gases. This is done by running the fan long enough to purge at least four or five volumes of the chamber. This is controlled by a timer built into the combustion safeguard system. If the purge cycle is not long enough, the system will not fire.
- **Flame sensor:** This sensor monitors the presence of a pilot or main flame. If ignition does not occur immediately, unburned fuel will accumulate in the chamber. Delayed ignition could result in an explosion. If a pilot flame does not appear within 10 to 15 seconds, the combustion safeguard system will abort the start-up.

The above safety devices apply to gas or oil fired units. Because oil is a liquid rather than a vapor, additional interlocks are necessary to assure oil is at the proper atomization, temperature and pressure.

Maintenance and testing

All safety control devices must be maintained regularly to ensure they are in proper operating condition. Manufactures usually issue guidelines with respect to a maintenance and testing schedule. Competent personnel who are familiar with the equipment should conduct the tests. Records of the tests should be maintained for trend analysis and follow-up.

Recommended testing frequencies for the combustion safety control system components are as follows:

MONTHLY

- Flame detector system
- Fan and airflow interlocks
- Check SSOVs for leakage
- Low-fire interlock
- High steam pressure or temperature interlock
- Fuel pressure and temperature for oil
- High and low pressure interlocks for gas

SEMIANNUALLY OR ANNUALLY

- Proper flame color and shape and exhaust color
- Air flow or pressure switches
- Damper high and low fire interlocks
- Flame scanners and other safety controls
- Piping, hoses, wiring and electrical connections of interlocks
- Instrument calibration

AS NEEDED

- Disassemble and clean oil atomizers
- Clean strainers

The given schedule is a minimum guideline. Based on operational environments, the testing schedule frequencies may have to be increased.

risk topic

*** It is important to remember that even the most up-to-date combustion safeguard system is composed of electro-mechanical devices that demand periodic inspection and testing. They are no different than any other industrial loss control systems such as automatic sprinklers, fire pumps or fire extinguishers. When an emergency condition presents itself, having these systems in proper working order may save your facility and prevent extended business interruption.

References

NFPA 31 – Installation of Oil Burning Equipment

NFPA 54 – National Fuel Gas Code

NFPA 86 – Ovens & Furnaces NFPA 86C - Industrial Furnaces Using a Special Processing Atmosphere; NFPA 86D - Industrial Furnaces Using Vacuum as an Atmosphere

NFPA 85 – Boiler & Combustion Systems Hazards Code

FM Global Data Sheets 12-69/6-4 Oil & Gas Fired Single Burner Boilers and Data Sheet 6-20 Space Heaters)

ASME CSD-1 Controls and Safety Requirements for Automatically Fired Boilers

UL 296 – Oil Burners

UL 795 – Standard for Commercial Industrial Gas Heating Equipment

UL 726 – Oil Fired Boiler Assemblies

For more information

416-586-2740

E-mail us at

risk.services@zurich.com

or visit

www.zurichcanada.com

ZURICH®

Because change happenz®