

# 15 Minutes To **SAVE YOUR LIFE**

## **10 dangerous combustion and fuel system sins and how to avoid them**

**T**his article is intended to help those who do not work with combustion equipment on a regular daily basis, whether it is boilers, metal-melting equipment, or paint-drying ovens, to screen for 10 obvious problems that could be deadly. This is no substitute for a skilled technician, but it can help to save lives if you are guilty of even one of the 10 deadly combustion equipment sins that follow. All of the 10 deadly sins illustrated below are real-life examples of what

testing plugs that do not appear to have ever been removed. This is an obvious sign that the required gas train automatic valve tightness testing is probably not taking place.

Gas trains keep gas out of the combustion chamber when no combustion is taking place through a series of tight closing, specially designed shut-off valves that are spring-loaded to close. These are the safety shut-off and blocking valves.

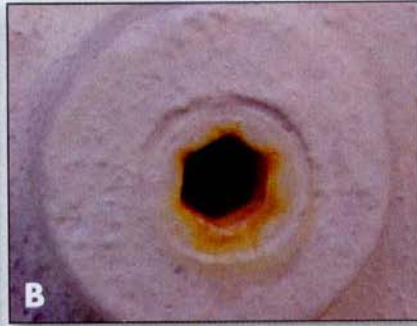
Equipment codes and laws require these valves to be tightness tested on a regular basis. The proper checkouts and testing are seldom performed on the building-code required schedules.

Leaking gas through these valves into a combustion chamber can enhance the chances of an explosion.

2) *Control panel hazards: critical safety components are mistakenly jumpered out and/or unreliable wiring and controls used.*

Photos C, D, E and F show evidence of jumpered out safety components, poor wiring installations, and/or poor documentation practices. Photo C indicates wiring not labeled and not arranged so that it can be understood without a high probability of error. The wiring diagram shown in Photo D has been customized in the field. This may or may not be accurate or correct.

Bypassing safety circuits can be disastrous. In the case of Photo E, an obvious electrical jumper wire that bypasses a con-

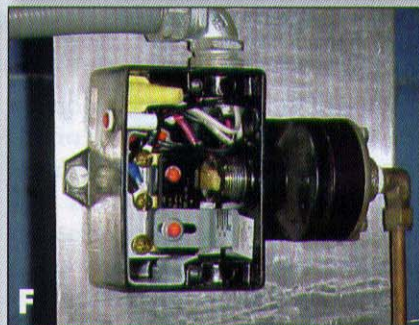
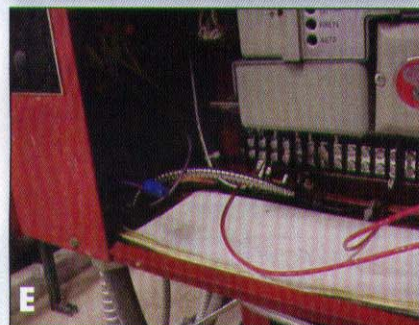
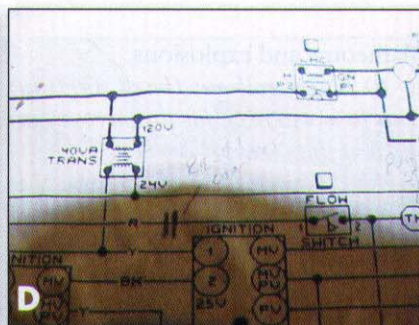
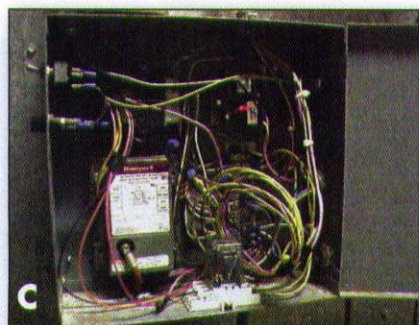


**PHOTOS A & B. Tightness testing of safety shut-off valves and blocking valves is not being carried out.**

we have seen when asked to evaluate the safety of combustion equipment. All of these examples could make for a dangerous working environment that could result in a fire or explosion under the right conditions.

1) *Tightness testing of safety shut-off valves and blocking valves is neglected.*

Photos A and B show evidence of valve



**PHOTOS C, D, E, and F. Bad things that can happen in control panels.**

control exists. It is a wire that is not the same as the others, is connected with alligator clips, and is of a different gauge and color. In Photo F, a Popsicle stick is broken off and jammed into an air-switch contact to hold it open. These are things you want to look for and find before you try to start equipment.

3) *Obsolete burner management systems can make for long outages and less protection.*

The burner management system (BMS) in photo G is a new model.



**Photos G and H. Obsolete burner management systems.**

An older electromechanical model is shown in Photo H. The BMS is the most important single safety component that exists for any piece of gas-fired equipment. Recent advances have put more features and

safety into this equipment. For example, newer BMS have purge timers that are solid state and

not adjustable. Many explosions have occurred where purge timers have been turned down in the field, making for ineffective removal of

flammable mixtures before pilot light-off cycles have occurred. Another important issue is BMS obsolescence. If you have a BMS or component fail that is no longer manufactured, it could take you many days of rewiring for a newer



**PHOTOS I and J. Valves in the instrument lines can render switches / instruments ineffective.**

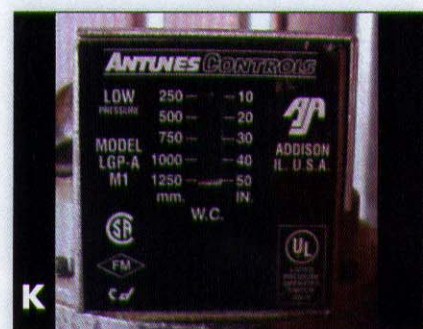
different style to be installed. Can you afford this kind of downtime?

4) *Valves in the instrument lines can render switches/instruments ineffective.*

Valves in instrument lines can be left in the closed position, rendering switches out of service and functionally incapable of operating. This could leave you and your equipment unprotected. They should always be removed or at least locked open as soon as they are found. This especially applies to high/low gas-pressure-sensing lines (Photo I), steam pressure switches, and water column connections (Photo J).

5) *Setpoints that are obviously wrong can render switches and instruments ineffective.*

Instruments and/or safety devices without correct setpoints provide little or no protection. The gas pressure switches shown in Photos K and L have setpoints pulled all the way to one side or the other. These are most likely not set correctly. Improper gas pressures could cause



**PHOTOS K and L. Setpoints that are obviously wrong.**



**PHOTO M.** Flame roll-out (hard starting) can be a warning for dangerous conditions that may get worse.



**PHOTOS N, O and P.** Automatic valve actuator failures can make for downtime and hazardous operating conditions.

flameouts and explosions.

6) *Flame roll-out (hard starting) can be a warning for dangerous conditions that may get worse.*

When the bottom of equipment is burned or scorched, it may indicate flame roll-out. This can occur when flues are partially blocked and/or fuel/air mixtures are set incorrectly. In these cases, combustible mixtures and flames can exist outside of the firebox.

One of the risks is catching on fire things that are near the base of this equipment. Another is that as things continue to degrade, the flame roll-out condition could turn into a catastrophic explosion from the accumulation of unburned gasses that ignite at once.

7) *Automatic valve-actuator failures (safety shut-off valve, blocking valve, pilot, or vents) can make for downtime and hazardous operating conditions.*

Hydraulic-valve-actuator failures are sometimes indicated by the presence of hydraulic fluid on a valve's exterior. Photos N, O, and P show oil stains on the sides of valves (N), puddling at the valve (O), and obvious excessive leakage (puddling under the equipment) (P). When you find these conditions, it indicates that some of the actuator's hydraulic fluid has leaked out. These valves are usually spring-loaded to close (not needing the hydraulic fluid for closing). The risk here is mostly one of equipment downtime when you least expect it because the hydraulic fluid is needed to open the valve to light the unit.

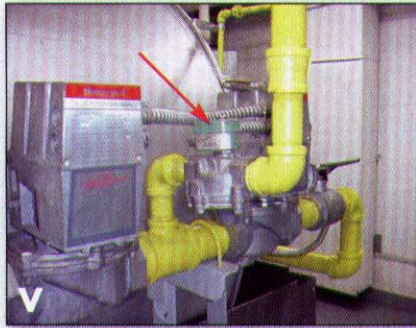
8) *Lubricated plug valves can be leaking through in the closed position or frozen in place and inoperable.*

Lubricated plug valves fail a number of ways, including leaking through when in the closed position and being stuck in the open or closed positions. Our inspections at more than 200 sites found that

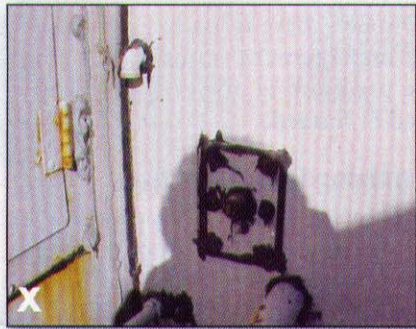


**PHOTOS Q, R, S, T, and U.** Leaking plug valves.

more than 60 percent leaked through in the closed position. A typical plug valve including the body, plug, and lubricant coating



**PHOTO V (Typical gas-train vent valve) and W (Typical vent termination on roof).**



**PHOTOS X, Y, and Z. Vent Terminations can be blocked with insect nests.**

on the plug that makes the seal, is shown in Photo Q. A frozen valve that cannot be closed in an emergency is seen in Photo R. Exterior stem corrosion is shown in photo S. A valve that has been painted shut is shown in Photo T. A valve in the closed position that is leaking through the inside of the pipe

downstream is shown in Photo U.

Lubricated plug valves need to be properly maintained on a regular basis. This means installing the proper sealant material and making sure the valves are exercised.

9) *Vent valves can fail open, disturbing burner operating conditions, and putting live fuel on roofs and improper mixtures into burners.*

Normally open vent valves are installed in gas trains to improve safety when equipment is off (Photo V). They allow gas leakage through the first automatic valve to get outside, instead of to, the firebox (Photo W). When the burner tries to light, they are supposed to close tight so all the gas goes to the burner. If they are failed and leaking, they can vent natural gas from the gas train while the burner is trying to operate.

This makes for risks on the roof from ignition sources. It also makes for burners with unstable flames that cannot stay lighted. If this happens, back-up systems must recognize the loss of flame and be called upon to shut gas off. If these fail, an explosion is likely.

10) *Outside vent terminations can be blocked with insect nests.*

Most instruments and switches are vented with pipes outside to safe locations (Photo W) to allow for proper operation and for gas to escape if a diaphragm failure occurs. Vent terminations are often found to be blocked with insect nests, as

## Preventing Disaster

Combustion system neglect requires a culture change to overcome. This is best achieved from awareness and re-training. Consider the case of a lowly 100-gal.-hot-water heater. The energy stored in a 100-gal.-hot-water heater can be equivalent to 10 sticks of dynamite. If you really had 10 sticks of dynamite stored at your facility, you would treat it with a lot of respect.

Please let this not be your first and final combustion equipment soul search, but instead only a wake-up call. This area of safety is not like fall protection or making employees wear safety glasses. This equipment has the power to harm many people and cause great destruction.

seen in Photos X and Y. A clogged vent can mean that there is no protection from leaking safety shut-off valves or blocking valves or for relieving failed components. Safety codes require protected vent terminations with screening devices installed, as seen in Photo Z.

### About the author

*John Puskar, PE, is principal of Combustion Safety Inc. in Cleveland, Ohio. His is a licensed engineer and a member of the National Fire Protection Association's national codes and standards committees for ovens and furnaces (NFPA 86). He can be reached at 216 749-2992 or by email at [jpuskar@cec-consultants.com](mailto:jpuskar@cec-consultants.com).*