Burner Management Enhancements for Reduced Heater Downtime

Jeff Peshoff
AWC, Inc.
jeff.peshoff@awc-inc.com

Contributors:
Randy Hamilton – AWC
Alan Cook – Triad Control Systems
Frank McIlwain – Automation Control Engineering
Logan Didier – AWC

AWC, Inc.
6655 Exchequer Drive
Baton Rouge, LA 70809
May 10, 2020

Keywords: combustion, burner management system (BMS), flame safeguard (FSG), interlocks, troubleshooting, uptime, Honeywell, Maxon

Summary

Engineers can greatly improve the safe and effective operation of ovens, furnaces, and fluid heaters by requiring operator interfaces designed for troubleshooting burner management systems (BMS).

Burner Management


Photo courtesy of Honeywell-Maxon.

Ovens, furnaces, and fluid heaters that use fuel gas for combustion are common in the process industry. Examples include petroleum furnaces, heater-treater units, glycol heaters, thermal oil heaters, air-drying heaters, and oxidizers. These systems are often provided by combustion original equipment manufacturers (OEMs) as an integrated package with a fuel train, local controls, burner management system (BMS), and required instrumentation. **Burner management is critical to the safe and effective operation of these systems.**

Opportunities for Improvement

Operators are often frustrated by burner trips and problems starting or restarting a burner. Troubleshooting the source of these problems can be an additional source of frustration. While determining the root cause can sometimes be complex, some common problems can be addressed by giving operators more streamlined information about the combustion operations and associated safety system.

The heater package shown includes enhancements proven to provide long-term operational value. The enhancements include Honeywell/Maxon SMARTLINK® combustion air/fuel controls[1] along with a local BMS human machine interface (HMI). An October 21, 2019 *CONTROL* magazine article[2] noted operational enhancements must be specified by the owner because OEMs are typically not incentivized to provide the "latest and best technology consistent with plant standards."

Packaged combustion equipment is certainly no exception to this view, and the drive for the most commercially competitive bid can lead to a minimalist approach when considering the burner safety system and associated operator interface. Not only can processing facilities end up with non-plant-standard instrumentation on combustion packages, but inadequate consideration of how operational problems will be diagnosed can result in unnecessary downtime and increased maintenance costs associated with the need for external specialty experts.

More Information about the Purging Sequence

The purging sequence allows fresh atmospheric air exchange in the combustion zone through the flue to prevent any accumulation of combustibles in the system. In a forced and/or induced draft system, this involves proving fans are running, adequate draft is present, and appropriate dampers are fully open for a prescribed time period to ensure removal of combustibles. Natural draft furnaces must ensure combustible removal is achieved by allowing adequate time before light-off. More recent approaches can involve utilizing fast-response, in-situ O_2 and CO analyzers to ensure burner operation is kept within acceptable operating limits, with start-up permissives and shutdown interlocks tied to an indication of an excessive fuel rich condition.

A burner management system works to manage the hazards associated with burner operation using permissive-based sequences and interlocks for safe startup/light-off, operation, and purge/restart/light-off.

More Information about Permissives

In order for the burner in a furnace to be started safely, the control system requests “permission” from several process switches, including high and low fuel pressure, air fan flow check, exhaust stack damper position, etc. Each process condition is called a permissive, and each permissive switch contact is wired in series, so that if any one detects an unsafe condition, the circuit will be opened.

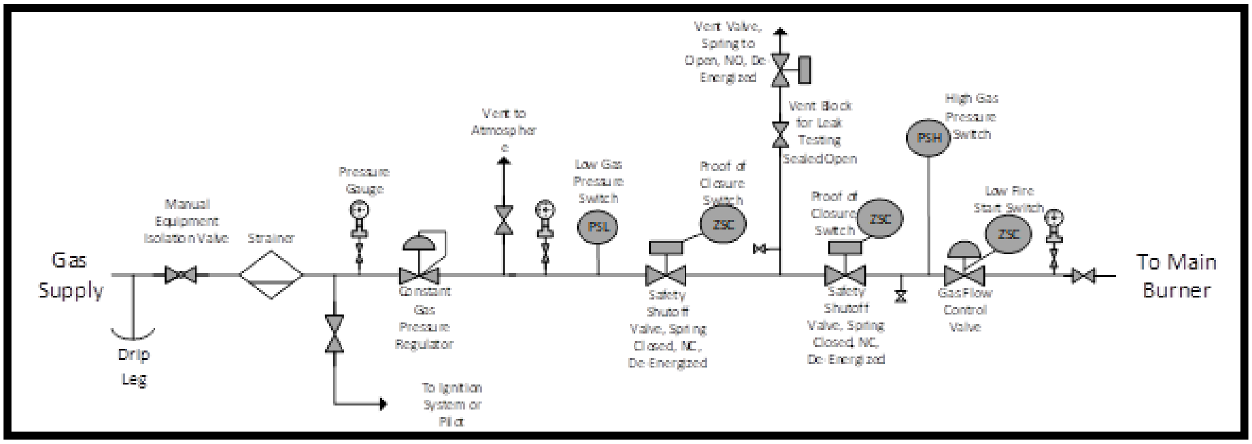
“Switch contacts installed in a rung of ladder logic designed to interrupt a circuit if certain physical conditions are not met are called **permissive contacts**, because the system requires permission from these inputs to activate.” Source

“Switch contacts designed to prevent a control system from taking two incompatible actions at once are called **interlocks**.” Source

Permissives and shutdown interlocks vary by stage (i.e., pre-ignition, purging sequence, light-off, release to main-flame, etc.) to minimize potentially hazardous conditions. Each system presents unique sequences and interlocks based on the specific operation and hazards of the combustion system.

The number and type of permissives and shutdown interlocks required by the Authority Having Jurisdiction (AHJ) and associated with recommended practices (such as ASME CSD-1, NFPA 86, NFPA 87, API 556, or plant-specific IEC 61511 safety instrument system [SIS] approaches) will typically vary with burner size (BTU/hour output).

For illustrative purposes, an example of a single-burner fuel gas train is shown below with a subset of typical switches associated with BMS permissives.



In the pre-ignition stage, proof of closure on the safety shutdown valves (SSVs) is required but not in other operating contexts. Other safety shutdown interlocks are the flame detector, applicable furnace temperature measurements, high flue gas temperature, and combustion air supply interlock (fan-run contact and/or draft switch). Permissives such as damper position for purge and fuel gas control valve safe start position are critical for initial light-off. Other process side interlocks such as high pressure, temperature, or level are typical depending on the heater application. A local emergency stop switch is also required. Some interlocks that are active during pre-ignition and/or light-off are not active during normal heater operation. System complexity will increase if the burner system includes multiple fuel firing, such as a capability for both natural gas and fuel oil.

Any one permissive or shutdown interlock can cause a burner trip or prohibit progress of the startup sequence. This can provide a challenge for operations personnel when confronted with a burner not functioning correctly. Even so, packaged combustion systems may not provide an intuitively obvious indication of which particular permissive isn't satisfied or is active.

> *More Information About Analog Instrumentation*
> Some functional safety approaches utilize analog instrumentation rather than the discrete switches to take advantage of available instrument-health diagnostics and because of the greater potential for a failed switch to remain in a safe state even in a potentially hazardous condition.

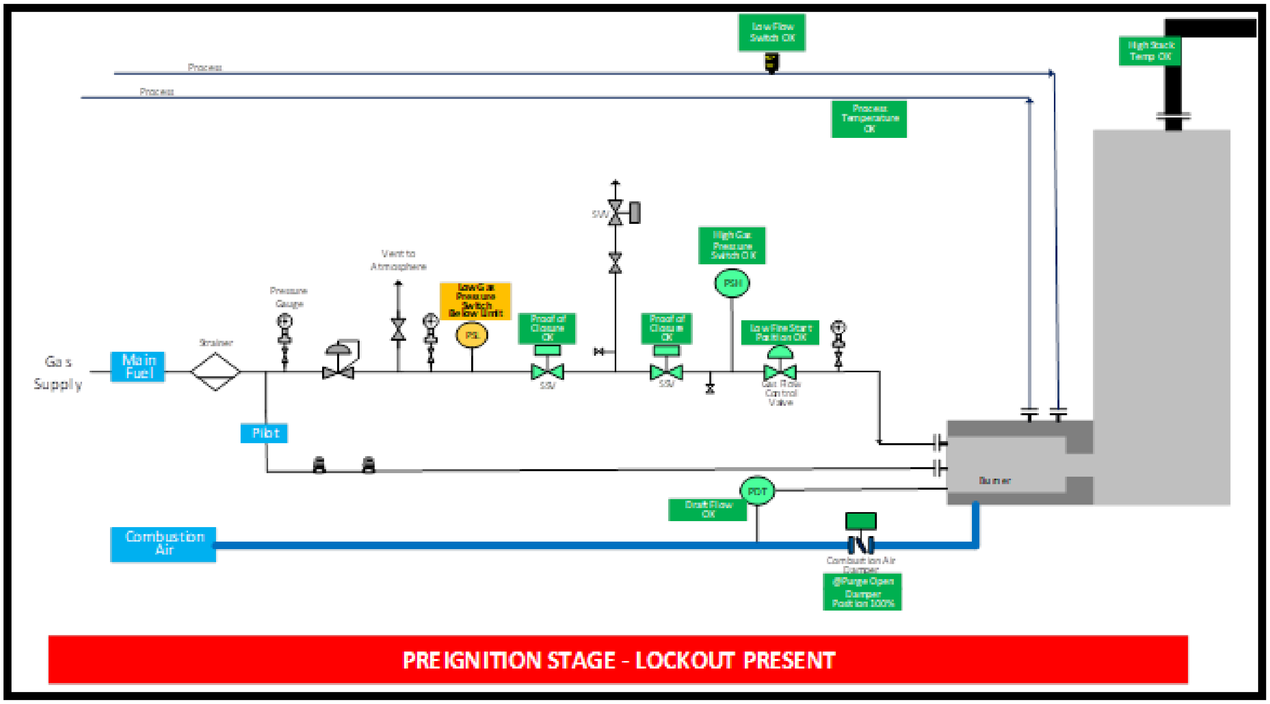
"Economy" combustion packages will typically have some permissive contacts wired in series and external to the flame safeguard controller (FSG) termination points or BMS logic solver I/O with no individual status indication. A local flame safeguard controller can be interrogated for codes that provide some indication for troubleshooting, but a qualified I&E technician may be needed to check the status of individual contacts in order to isolate the problem. In addition, without an intuitive operator interface, it is essential that the responding technician have a basic grasp of the burner interlock context and sequence in order to quickly troubleshoot what may be preventing burner operation.

This becomes an even greater concern when combustion equipment is remotely located, as is typical with upstream and midstream oil and gas applications. A roving worker responsible for field operations may not have the expertise to troubleshoot a heater that goes down and will not restart, necessitating that experienced personnel travel to the site, increasing costly downtime. When a qualified troubleshooter does arrive, it may be found that a needed replacement part must be retrieved, further delaying restart of the heater.

Given these predictable circumstances, it is obvious how detailed burner status information can impact costs and labor, even without remote access to the local controls, such as through a SCADA system. Local panel indication of the combustion schematic with interlock and controls status can not only save time but can also serve as an easy-to-understand aid for operations personnel.

Consider the following example: A local operator finds that a glycol heater will not restart after a system trip. Fortunately, the local heater control panel was supplied with an intuitively-obvious graphical indication and/or display verbiage that the low fuel gas pressure switch is in alarm. A simplified graphic, such as the one pictured below, easily identifies the low fuel gas pressure switch as “below limit.”

Easily seeing the low-fuel gas pressure condition on the local HMI, the operator then physically verifies that the gas supply pressure is actually within acceptable range and reports the specific low pressure switch problem to the area I&E maintenance contact. An I&E tech arrives on site with the replacement pressure switch; in short order, the heater is back in service. Of course, if remote monitoring of the burner is implemented, then the potential equipment availability to the process can be even greater, but the simple inclusion of a functional local operator display with individual interlock status can easily pay for itself. Even retrofit of a local panel to provide such capability can be relatively inexpensive—typically less than a $10K for a single-burner system.



It is also helpful to provide operators with a view of the permissive sequence in the burner management system with first-out indication. First-out indication allows the operator to immediately view the first individual permissive in an active sequence string which is not satisfied. An example of such a local HMI screen build is shown below. *This client chose the Honeywell ControlEdge HC900[3] solution for BMS and combustion control.*

> *More Information about Cloud-Based Remote Monitoring*
>
> Cloud-based remote monitoring for critical thermal process systems is now available as a service to improve asset performance and increase plant uptime. Honeywell Thermal IQ™ is a cyber-secure offering that includes advanced tools to optimize control performance and makes critical thermal process data available anytime, so users can optimize operations, predict plant failures, and eliminate unplanned downtime. Key performance analytics, alerts, and status information provide a detailed view of system parameters, all available on a smart phone or tablet. Source

Local BMS Panel Interface with a DCS Basic Process Control System

Most larger process plants utilize modern distributed control systems (DCS). However, control room operators commonly have little usable information in the DCS for combustion equipment status monitoring. This is partly due to the reality that fired equipment packages are commonly supplied without consideration for connectivity to the plant process automation system. In addition, recommended combustion safety practices drive burner safety controls to a panel adjacent to the heater or furnace. The understood intent of the local control panel is the assumption that an operator should be physically present to monitor the burner system during startup and troubleshooting.

Local flame safeguard (FSG) and combustion control systems, such as the Honeywell SLATE™[4], allow for segregation of all burner management permissives, discrete or analog, while providing status indication to a parent DCS system via Modbus utilizing a SCADA interface. For those plants with Honeywell Experion® PKS systems, Modbus communications can be handled via PCDI direct to a C300 controller. Honeywell also offers a ControlEdge™ Unit Operations Controller (UOC)[5], with a small envelope dimension for inclusion in a local burner panel, which can be integrated with a local FSG, allowing each BMS permissive to be isolated for status indication and facilitating native communications to a remote C300 controller or Experion® PKS Server.

Several such projects have been successfully executed by AWC, Automation Control Engineering, and Triad Control Systems, which delivered substantial improvements.

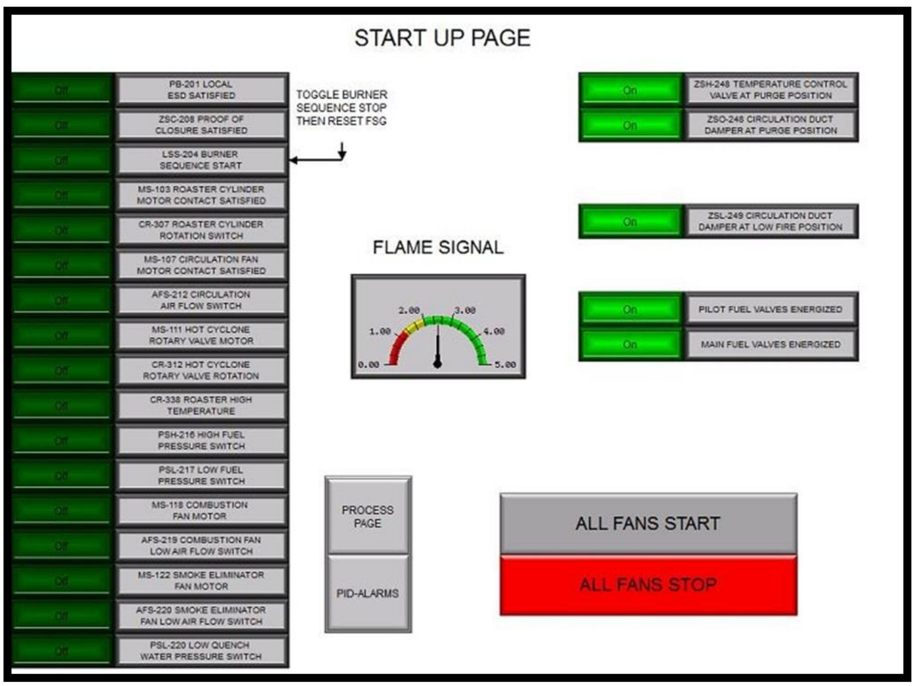


Image courtesy of Triad Control Systems, Baton Rouge, LA.

---

1 Maxon Smartlink® https://www.maxoncorp.com/products/valvesparallel/smartlink-mrv-electronic-ratio-valves/?back=product

2 "Instrument Specification: Where We Are and Where We Should Be." *Control* (ISSN-1049-5541). Greg McMillan.

3 Honeywell ControlEdge HC900 https://www.honeywellprocess.com/library/marketing/case-studies/CaseStudy_EnLink-BurnerSafety.pdf

4 Honeywell SLATE™ https://combustion.honeywell.com/slate/

5 Honeywell ControlEdge™ Unit Operations Controller (UOC) https://www.honeywellprocess.com/library/marketing/notes/PIN-ControlEdge-UOC.pdf