White Paper
June 2021

Combustion Management

Meeting the Challenges of BMS Applications

Burner Management Solutions

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A Burner Management System (BMS), also sometimes referred to as a Flame Safety System (FSS), is a critical component of a combustion process whether it be a boiler, heater, kiln, dryer, thermal oxidizer, incinerator or other unit. This is the system that protects against hazardous firing conditions, which could result in harm to the process equipment and any personnel around it.

First and foremost, a BMS sequences the initial firing to ensure safe light-off and monitors the process to shut it down if an unsafe situation is detected. It is also important that the BMS provides functionality to assist operations in smoothly starting the combustion process and in troubleshooting the situation when problems occur. Finally, the BMS must be cost effective to implement and maintain while being highly reliable over the long term.

Burner Management Application Challenges

Code Compliance.

A BMS must be designed and implemented in accordance with applicable safety codes for the process and the site location.

Holistic Approach.

All combustion process aspects, including piping, field devices, control platform, and sequence configuration must be considered in BMS design SIL Rated Platform. It is recommended that the flame safety configuration be implemented on a Safety Instrumented System (SIS) hardware platform.

Devices and Elements.

Most BMS issues occur in measurement devices and final elements; use of transmitters rather than switches and smart devices is recommended. Separate but Integrated BMS logic must reside in separate control hardware, but an integrated safety platform solution delivers optimal performance and cost.

Logic Configuration

The burner sequence configuration should be straightforward to understand and maintain.

Operator Information

Clear indication of the status of the firing sequence needs to be presented to operations personnel to assist in process start-up.

Maintenance Information

Specific description of the problem must be provided to maintenance personnel when there is a trip or issue with start-up.

Implementation Cost

Installation of the burner management solution must be completed in a cost effective manner.

Addressing BMS Application Challenges

Code Compliance and Holistic Approach

A variety of codes and standards apply to burner management applications depending on the process involved and the site location. The burner management engineering team, the authority having jurisdiction at the site, and potentially an insuring body must work together to interpret and apply the appropriate standards for the particular situation.

Sampling of Common BMS Codes and Standards

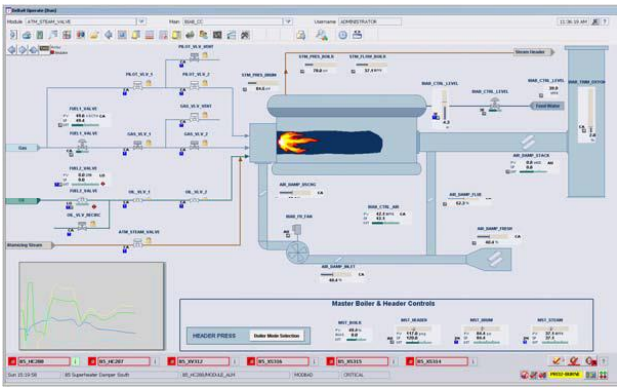
- CSA B149.3 / CSA B149.1
- IEC Standards 61508 and 61511
- European EN 50156 (Furnaces)
- U.S. NFPA Standards 85 (Boilers) and 86 (Furnaces)
- ANSI/ISA S84.01
- Canadian Standard CSA B149.3
- API Code of Practice 560 (Fired Heaters)
- Australian Standards AS 1375, AS 3814, and AS 61508

In all cases, consideration of a burner management application must involve the overall firing process, not just the safety system controller and its programming. This is generally defined to include the sensors, the logic solver, and the final elements.

Burn Management Solutions

Spartan can assist clients/EPCs with the process of defining their burner management requirements including making sure the applicable codes are met, while high functionality and long-term reliability is delivered. For example, Spartan experts conduct field surveys on existing installations to determine what scope should be included in an improvement or B149.3 compliancy project. These surveys are comprehensive, including all equipment and devices affecting burner management performance.

Typical Aspects of Burner Management Survey



- Fuel flow, pressure, and temperature measurements
- Fuel shut-off and vent valves
- Air flow measurements
- Air and FGR dampers
- Fan motors and/or drives
- Drum level measurements
- Igniters and flame scanners
- Fuel gun insert and retract (if applicable)
- Furnace pressure measurements
- Device installation and wiring
- I/O modules and wiring
- Controllers
- User interface consoles

SIL Rated Platform and Devices/Elements

Best practices for burner management applications have evolved in recent years, with the current consensus being that logic for these systems should be configured on Safety Instrumented System (SIS) hardware that can meet a defined Safety Integrity Level (SIL) when deemed appropriate.

Not all standards for burner management currently recommend treating the application as a safety system, but this is the direction in which the codes are moving. Emerson’s DeltaV SIS

smart logic solver family is TÜV-certified without exception for use in SIL 1-3 safety applications as defined by IEC 61508.

Components of a BMS include sensors, the system, and final elements. The SIS platform can help increase safety integrity of a BMS by continuously monitoring the ability of sensors, logic solvers, and final elements to perform on demand and diagnosing faults before they cause spurious trips. Replacing BMS field sensor switches with transmitters can reduce undetected sensor failures that can be dangerous.

Today's leading smart measurement instruments, such as Emerson's Rosemount™ and Micro Motion™ devices, go beyond detecting component failures to provide both transmitter and process diagnostics. Final elements such as fuel shut-off valves are critical to BMS performance. If a valve does not move when a potentially hazardous event occurs, there may be serious risk to personnel, equipment, and/or the environment. Digital valve controllers, such as Emerson’s FIELDVUE™ instrument, can provide automated performance monitoring and testing by enabling partial stroke testing while the safety valve is online.

Spartan delivers full BMS solutions using an integrated SIL rated hardware platform from sensors, to logic solvers, to final control elements. The use of digital intelligence and predictive diagnostics increases system availability while reducing life cycle costs and enabling straightforward regulatory compliance.

Separate but Integrated

A BMS must provide functionality that meets or exceeds the applicable codes and standards for the process for which it is intended to protect. It is also essential that the system be effective at supporting operating and maintenance functions. Furthermore, it is important that the system is cost effective to both implement and maintain over its lifecycle.

Burner management standards require independence between safety and process control hardware; however, there are clear advantages to having tight integration of the safety system

with the regulatory process controls. This integration lowers implementation costs, improves system functionality, and reduces maintenance costs associated with a BMS.

As an Integrated Control and Safety System (ICSS), Emerson's DeltaV SIS hardware for BMS, combined with DeltaV for process control, deliver the advantages of a tightly coupled safety and control environment. The integrated but separate architecture complies with standards for physical separation and independence of safety and control, delivering the benefits of total integration and total separation without the tradeoffs associated with the two extremes.

With a similar control configuration environment, single control database, and common user interface, implementation of an SIS rated BMS solution is more effective and less costly when the Emerson DeltaV/DeltaV SIS platform is used.

Advantages of the DeltaV SIS / DeltaV ICSS Platform

- Engineering support level reduced through common development tools
- Data mapping between systems is not necessary
- Single user interface with integrated alarming reduces training and improves performance
- Reduced maintenance training necessary
- Common control database lowers lifecycle costs

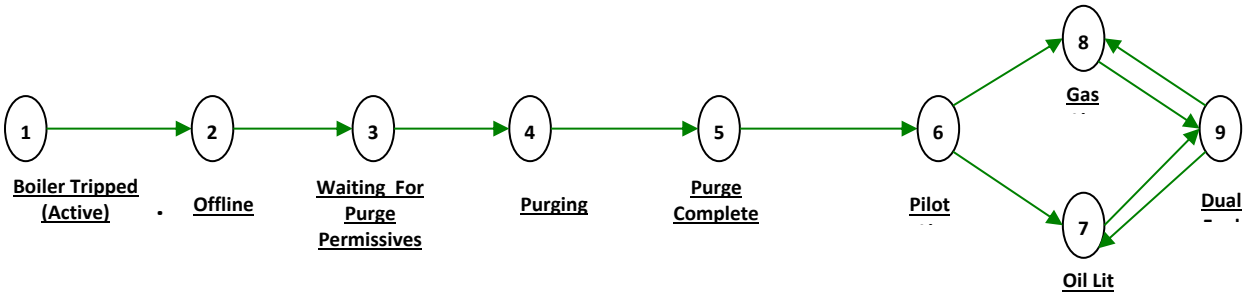
Logic Configuration

To simplify the initial configuration and start-up effort of a BMS implementation, and to ease troubleshooting and maintenance over its lifetime, it is necessary that the system logic be constructed in a manner that it is straightforward to engineer, easy to understand, and relatively simple to troubleshoot. Over the years, BMS logic has often been implemented in Boolean or ladder logic format. While serviceable, these formats were not always the easiest to configure or maintain.

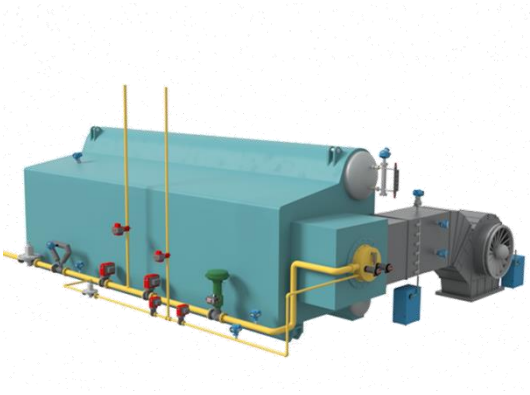
Techniques for BMS logic configuration have evolved in recent years such that design, programming, and troubleshooting have been made more intuitive and less complicated.

Complex and customized Boolean or ladder programming have now been replaced by specialized function blocks. Emerson's DeltaV SIS logic controllers are equipped with IEC 61508-certified function blocks particularly designed for the sequential nature of processes such as Burner Management Systems. Spartan has developed a unique methodology for specifying different burner states and required conditions in a simple matrix format. One page shows the states, active trip conditions, valve positions, and how to move from state to state. Configuration is greatly simplified.

For instance, this is an example of the configuration for a dual fuel boiler. It has 9 basic states for a main sequence.



Each Fuel also has a simple sequence associated with it. In this case there are three fuel sequences, the fuel for the pilot, oil, and natural gas. Each of these sequences is identical to each other and generally very straightforward.



Defining how to move from one state to another is typically clear-cut. It can be as simple as, during the purging state, that the transition to purge complete happens when the purge timer completes.

Each output is defined based on the state. The main block valves for the oil, for example, are only opened when the oil sequence is in the oil light-off or oil on states. As described next, function blocks manage these states, the transitions, and the outputs.

The following DeltaV SIS function blocks are key components used in developing a BMS application:

State Transition Diagram

This block implements a state machine, where each burner and the overall burner process is considered to be in one of a number of configurable states, with transitions between the states based on identified plant conditions. The function block changes state based on the values of its transition inputs. For example, purging, ignition, and running might all be defined states, with specific operator inputs such as start or plant inputs such as an accumulated air flow, signifying a change in state.

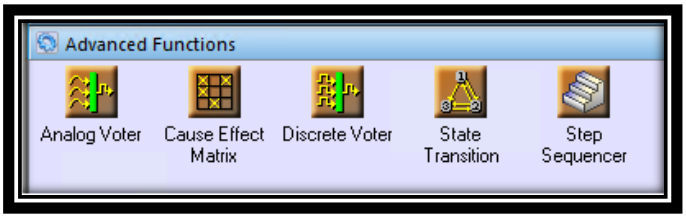
Cause and Effect Matrix

This executes interlock and permissive logic to associate inputs (causes) with outputs (effects) to control one or more final elements. The function block includes state-based cause masking, and allows different trip conditions for each of the defined burner states. A first-out trap feature quickly identifies the root cause of any trip condition, minimizing down-time and aiding troubleshooting.

Step Sequencer

The step sequencer block drives a number of discrete outputs based on the current burner state derived from the state transition block. This simplifies the logic greatly and makes checking the configuration straightforward.

BMS implementation and maintenance is now simplified. In addition, change management can now be more tightly controlled. DeltaV SIS change management supports regulatory requirements and streamlines IEC 61511 compliance. All changes in DeltaV SIS system logic may be captured based on the change, who made it, and when it was made.



Operator Information

Many industrial combustion processes run for months at a time, only being shut down and started up once or twice a year. For this reason, operations personnel may not be as familiar with startup procedures as they are with normal operating scenarios. Traditionally, many Burner Management Systems have not provided much assistance.

In the past, BMS implementations often did not help in startup situations because, as the combustion process was being brought on-line, there was not clear indication of the state of the startup sequence.

Operations personnel often were not presented clear indication of where in the sequence the process was and what particular interlocks were preventing the light-off procedure to advance. This has often resulted in start-up delays, time consuming troubleshooting, and at times, unsafe operating conditions. Spartan has improved the user interface for Burner Management Systems such that clear indication of the process status is provided to operations personnel at all times. The BMS actually assists personnel in bringing the combustion process safely on-line.

Information is delivered both graphically and with text. At a glance, users can see exactly where in the startup sequence the process is. If there is a permissive not met, this is indicated clearly with a full text description.

Maintenance Information

In the same way that clear status information should be presented to operations personnel, the maintenance staff needs access to details from the Burner Management System that will allow quick and uncomplicated troubleshooting of any combustion process issues. Traditionally, this has been a shortcoming in BMS installations.

BMS designs of the past have often been very difficult to troubleshoot and maintain due to limited visibility into sequence status, lack of first-out indication, and series wiring of multiple interlocks into a single logic controller input point.

Spartan has designed its BMS solution from the bottom-up to be straightforward to troubleshoot and cost effective to maintain over its lifetime. First, each required interlock is wired to a separate logic controller input point so that it can be monitored and tracked individually. Further, the status and health of Emerson smart devices can be checked continuously by the system so that issues can be identified before they cause unnecessary downtime or unsafe conditions.

The function blocks in Emerson's DeltaV SIS controllers provide first-out information that is simply displayed for maintenance and operations personnel with proper authority. Historical data collection saves all of the first-outs, authorizations, and other needed documentation. And further, when the DeltaV SIS BMS is implemented as an ICSS with a DeltaV process control system, interface issues between the BMS and combustion control functions are eliminated and BMS maintenance can be done using the same tools as are used for the overall process.

Implementation Cost

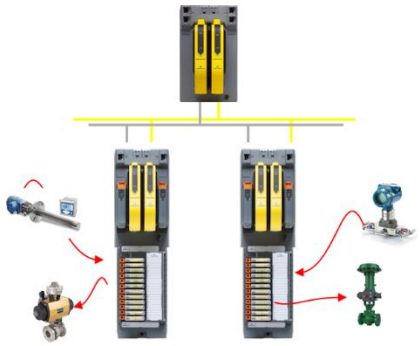
Burner Management Systems are installed to prevent dangerous combustion of fuel used in industrial combustion processes, and as such, they must be engineered rigorously and installed properly. In addition, the BMS should be cost effective to implement, operate, and maintain in order to support the overall business objectives of the site.

Spartan leverages multiple service and hardware capabilities in order to keep the cost of BMS implementations down while delivering excellent system performance:

* Application Experience Engineering personnel with extensive BMS experience are efficient at
* delivering high quality designs and configurations

* Standard Templates for hardware design and logic configuration are pre-engineered,
* saving time and providing superior system functionality
* Function Blocks DeltaV SIS function blocks reduce configuration effort while delivering
* superior system functionality and allowing easier troubleshooting
* Integrated Architecture Separate but integrated architecture of DeltaV SIS and DeltaV saves on
* engineering tools, footprint, and training requirements
* DeltaV SIS with Electronic Marshalling dramatically reduces engineering effort and field wiring costs
* Electronic marshalling for DeltaV SIS streamlines engineering efforts, reduces control system footprint, and dramatically decreases field wiring.
* DeltaV SIS electronic marshalling and characterization module (CHARM) technologies reduce BMS equipment footprint and eliminate traditional marshalling cabinets. Existing field device wiring can be connected to CHARM terminal blocks in field enclosures near those devices, thereby reducing installation cost.
* Individual CHARMs are available to connect to any I/O type, so Electronic Marshalling provides
* unprecedented flexibility to easily change or expand the BMS system and allows the hardware
* engineering effort to be separated from logic configuration. Re-work and commissioning costs are reduced by the ability to easily change I/O type and quantity in the field on a point by point basis late in the project development cycle.

Typical Delta V BMS Architecture



Emerson Meets and Beats BMS Application Challenges

With Spartan, BMS implementations are done cost effectively to meet all codes and standards while delivering a system that makes the process easier to run and maintain. With a combination of specialized engineering skills, pre-engineered designs, and unique automation system technologies, Spartan delivers solutions that meet the particular challenges of BMS applications:

* Systems are implemented in accordance with all applicable codes and standards
* The BMS is considered holistically, including piping and field devices as well as the logic controller and configuration and start up services
* Logic configuration is implemented on Safety Instrumented System (SIS) hardware
* Proper measurement devices and final elements are supplied as necessary
* A separate but integrated hardware solution is provided when possible to cut lifecycle cost
* Logic is implemented using state sequence tools to simplify understanding and ease maintenance
* Clear indication of the BMS sequence is provided to operations to aid process management
* First out logs are provided for maintenance to simplify troubleshooting
* Electronic marshalling is utilized to lower engineering and installation costs