Burner Management Systems

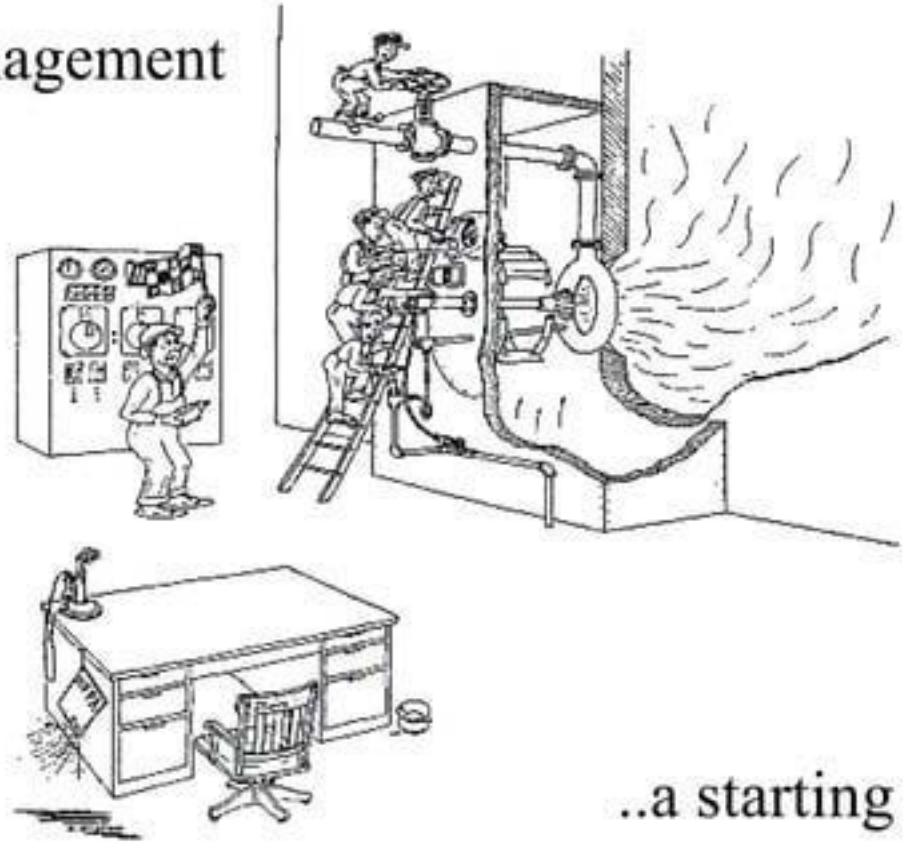
A Technical Discussion

Preferred Utilities Manufacturing Corp.

- Introduction
- Burner Management System Objectives
- BMS Design Standards and Definitions
- BMS Logic
- BMS Strategies and Hardware
  - Types of Burner Management Systems
- BMS Interface to SCADA Systems
- Summary

Introduction

Burner Management Systems..



..a starting point.

What is a BMS?

- A *B*urner *M*anagement *S*ystem is defined as the following:
  - A Control System that is dedicated to boiler safety, operator assistance in the starting and stopping of fuel preparation and burning equipment, and the prevention of mis-operation of and damage to fuel preparation and fuel burning equipment. [1]

1. From NFPA 8501 "Standard for Single Burner Boiler Operation"

Burner Management Objectives

- Sequence burner through safe start-up
- Insure a complete pre-purge of boiler
- Supervise safety limits during operation
- Supervise the flame presence during operation
- Sequence a safe shutdown at end of cycle
- Integrate with combustion control system for proper fuel and air flows

BMS Design Standards

- Each Burner Management System should be designed in accordance with the below listed guidelines to control and monitor all sequences of the start-up and shutdown of the burner
  - National Fire Protection Association (NFPA 8501 /8502 or others)
  - Industrial Risk Insurers (IRI)
  - Factory Mutual loss prevention guidelines
- Each burner management system should be designed to accomplish a safety shutdown in the event of an unsafe condition. (FAIL SAFE)

BMS Design Standards

- U.S. National Fire Protection Association (NFPA)
  - Governs safety system design on virtually all boilers (regardless of the process to be used to combust the fuel)
  - Requires the separation of the Burner Management System from any other control system
  - Requires the use of a hardwired backup tripping scheme for microprocessor based systems
  - Requires that a single failure NOT prevent an appropriate shutdown
  - Factory Mutual loss prevention guidelines.

NFPA 8501

- NFPA 8501 Standard for Single Burner Boiler Operation
  - Single Burner Boilers with fuel input greater than 12.5 mBTU/Hr (Approx. 250 BHP)
  - Single Fuel or Combination of Fuels (Common being Natural Gas / No.2 Oil / No. 6 Oil)
  - Simultaneous Firing

NFPA 8502

- NFPA 8502 Standard for Prevention of Furnace Explosions / Implosions in Multiple Burner Boilers
  - Multiple Burner Boilers with fuel input greater than 12.5 mBTU/Hr
  - Single Fuel or Combination of Fuels including Pulverized Coal
  - Emphasis on implosion protection (larger boilers with induced draft systems)

BMS Definitions

- Furnace Explosions
  - "Ignition of accumulated combustible mixture within the confined space of a furnace or associated boiler passes, ducts, and fans that convey gases of combustion to the stack"[1]
  - Magnitude and intensity of explosion depends on relative quantity of combustibles and the proportion of air at the time of ignition

1. From NFPA 8502 "Prevention of Furnace Explosions / Implosions in Multiple Burner Boilers"

BMS Definitions

- Furnace Explosions can occur with any or a combination of the following:[1]
  - Momentary loss of flame followed by delayed re-ignition
  - Fuel leakage into an idle furnace ignited by source of ignition (such as a welding spark)
  - Repeated Light-off attempts without proper purging
  - Loss of Flame on one Burner while others are in operation
  - Complete Furnace Flame-out followed by an attempt to light a burner

1. From NFPA 8502 "Prevention of Furnace Explosions / Implosions in Multiple Burner Boilers"

BMS Definitions

- Furnace Implosions
  - More common in large Utility Boilers
  - Caused by any of the following:
    - » Malfunction of equipment regulating boiler gas flow resulting in furnace exposure to excessive induced draft fan head capability
    - » Rapid decay for furnace gas temperature and pressure due to furnace trip

1. From NFPA 8502 "Prevention of Furnace Explosions / Implosions in Multiple Burner Boilers"

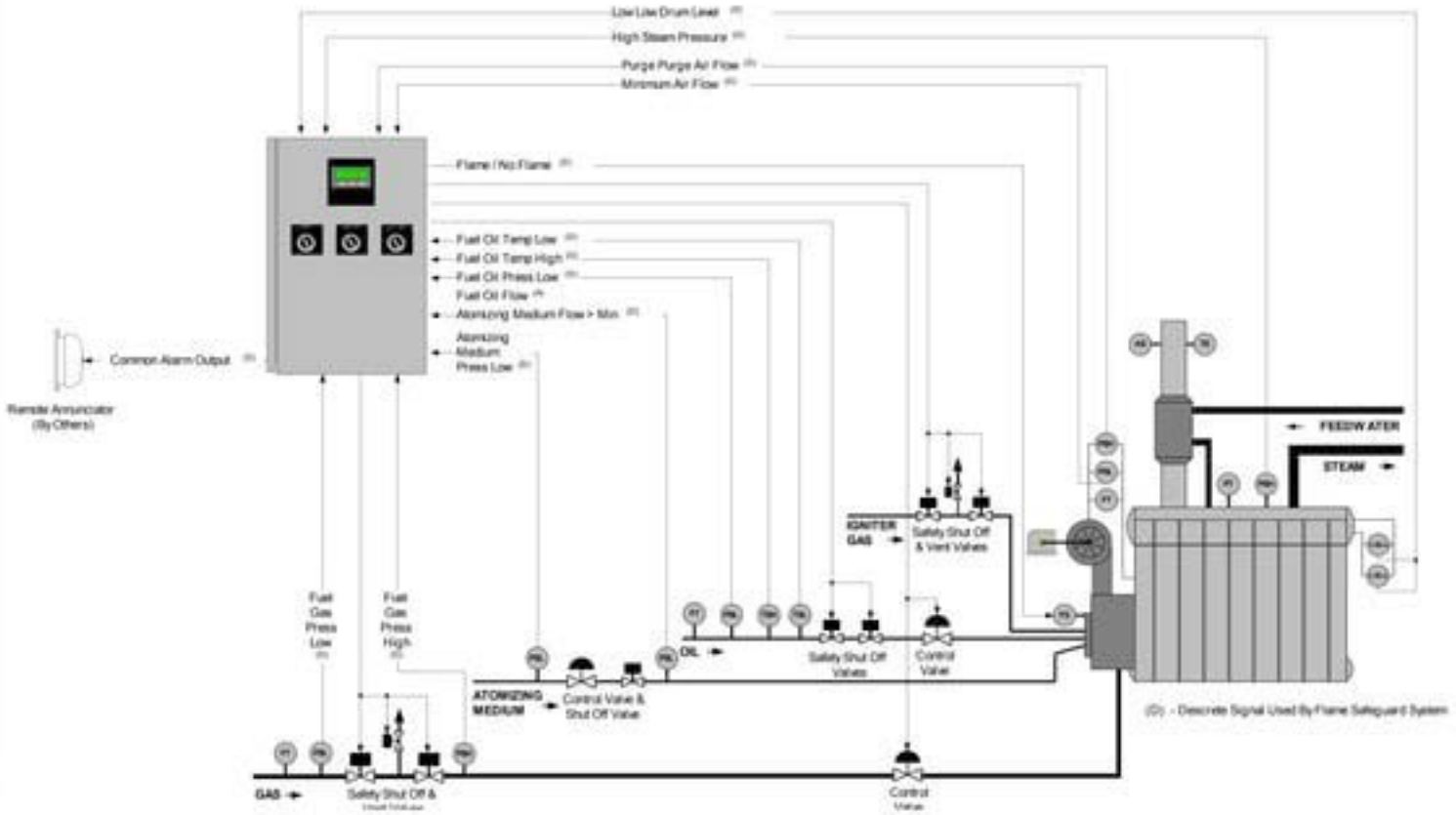
BMS Basic Definitions

- Common Terminology
  - Supervised Manual
    - » Manual Burner Lightoff with Interlocks
  - Automatic Recycling (Single Burner Only)
    - » Automatic Burner Start and Stop based on preset operating range (ie.. Drum pressure)
  - Automatic Non Recycling (Single Burner Only)
    - » Automatic Burner Start and Stop based on Manual command to start.

Types of Flame Scanners

- Infrared (IR) Detectors
  - Single Burner Applications
  - More Suitable with Oil Burning Flames
- Ultra-Violet (UV) Detectors
  - Multiple Burner Applications
  - More Suitable for Gas Burners and Combination Gas / Oil Burners
- Self Check Scanners
  - Flame Signal is interrupted at set intervals to verify proper operation of scanner

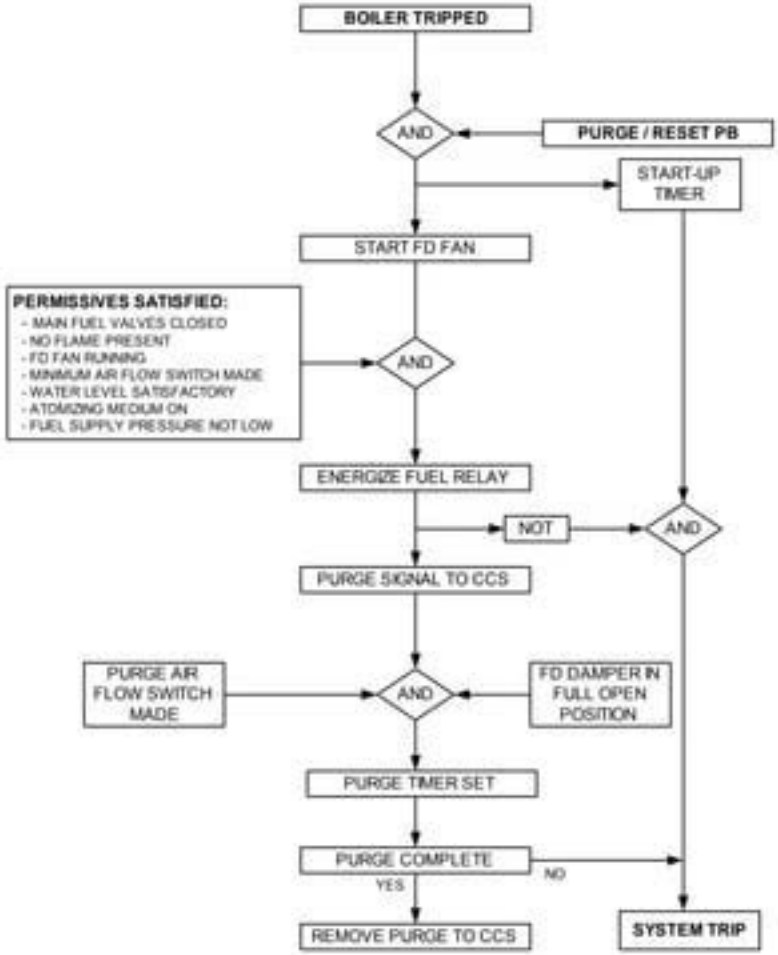
Single Burner BMS Inputs



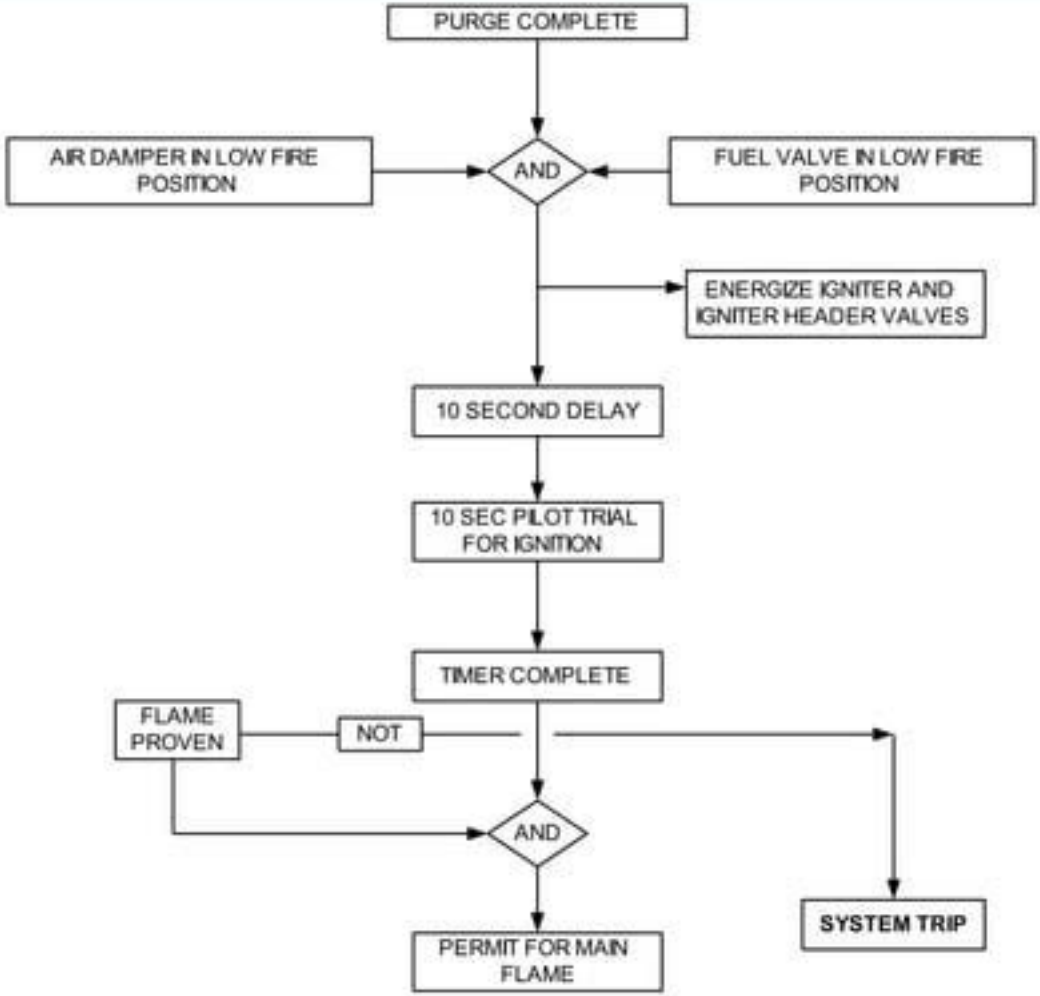
BMS Logic

- Burner Management Systems can be broken down into "Interlock Groups"
- Typical BMS Interlock Groups:
  - Boiler Purge
  - Igniter Header Valve Management
  - Main Fuel Header Valve Management
  - MFT (Master Fuel Trip) Logic

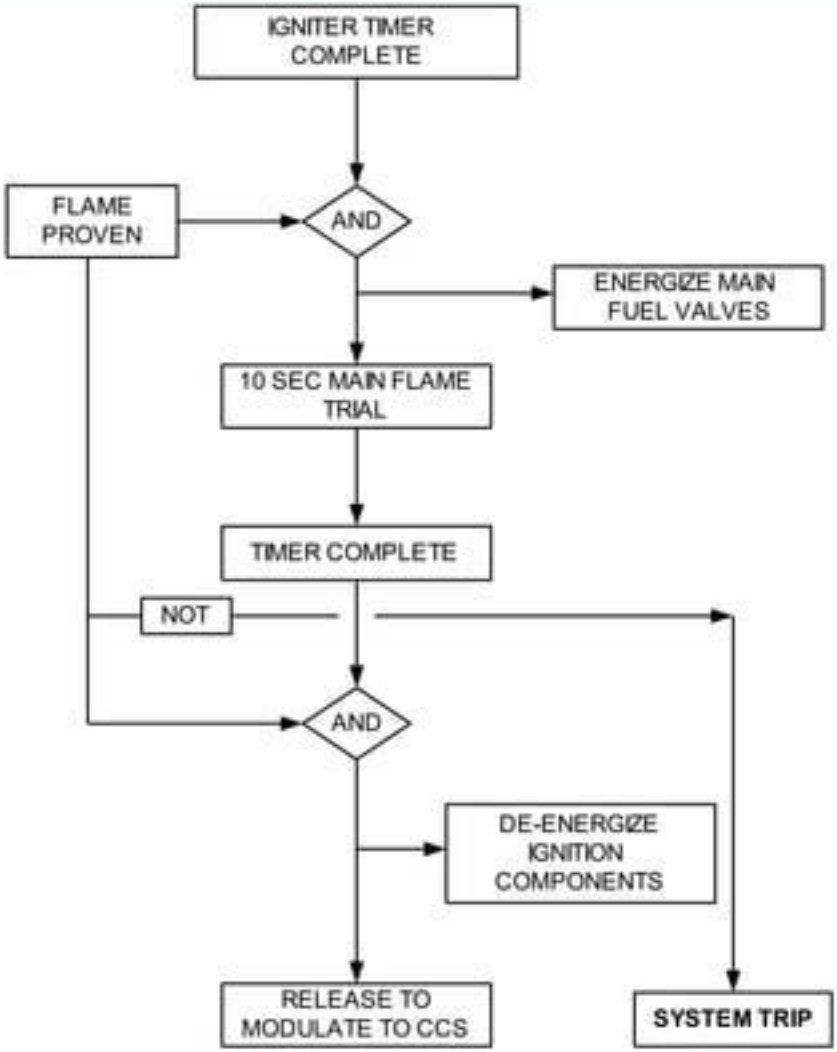
Purge Interlocks



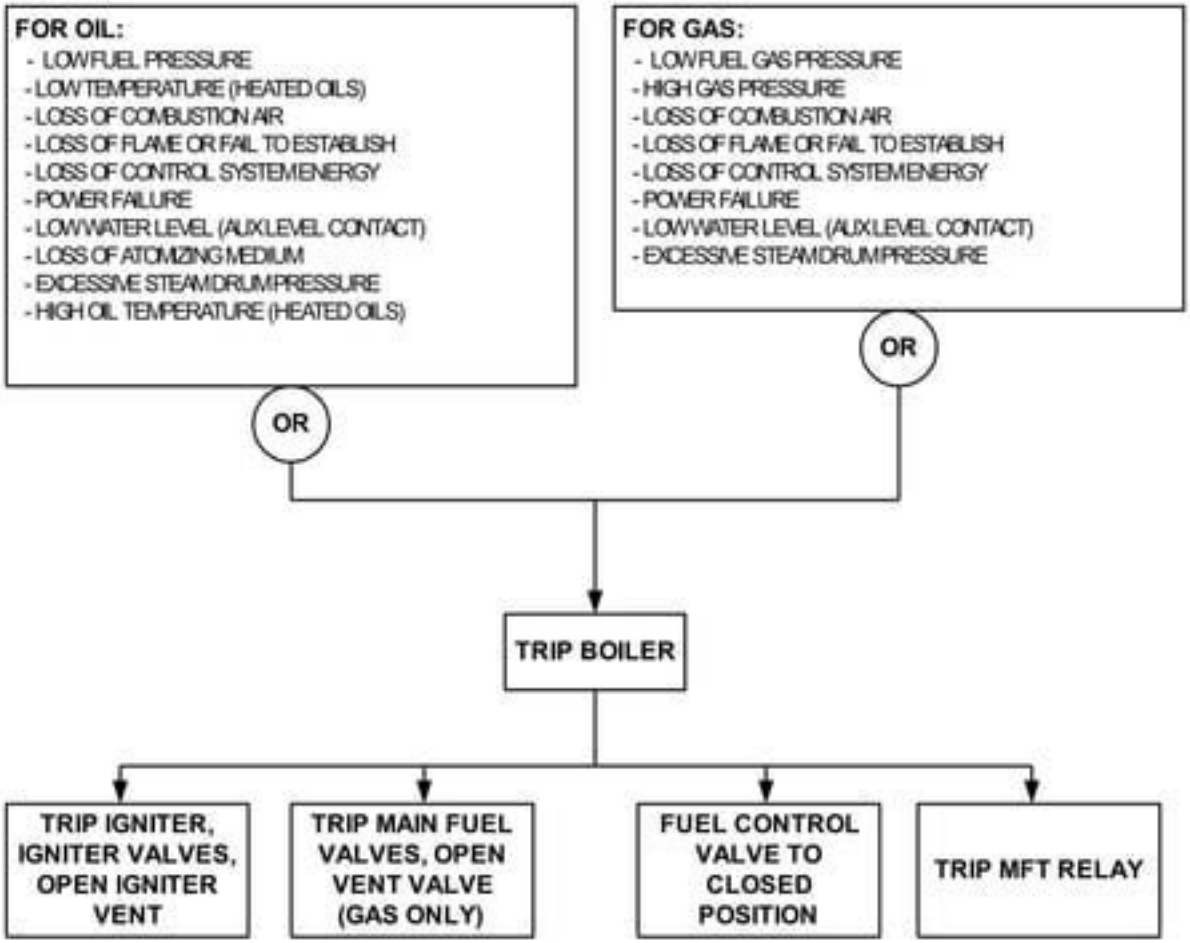
Igniter Interlocks



Main Flame Interlocks



Single Burner Main Fuel Trip



BMS System Types

- Early Burner Management Systems
  - Hardwired Systems
  - Solid State Systems
- Microprocessor Based Systems
  - Fireye E110 / Honeywell 7800 series with fixed Logic.
- PLC Based Systems
  - Programmable Logic Controller (PLC) Based
  - Powerful, versatile, expandable, more reliable.

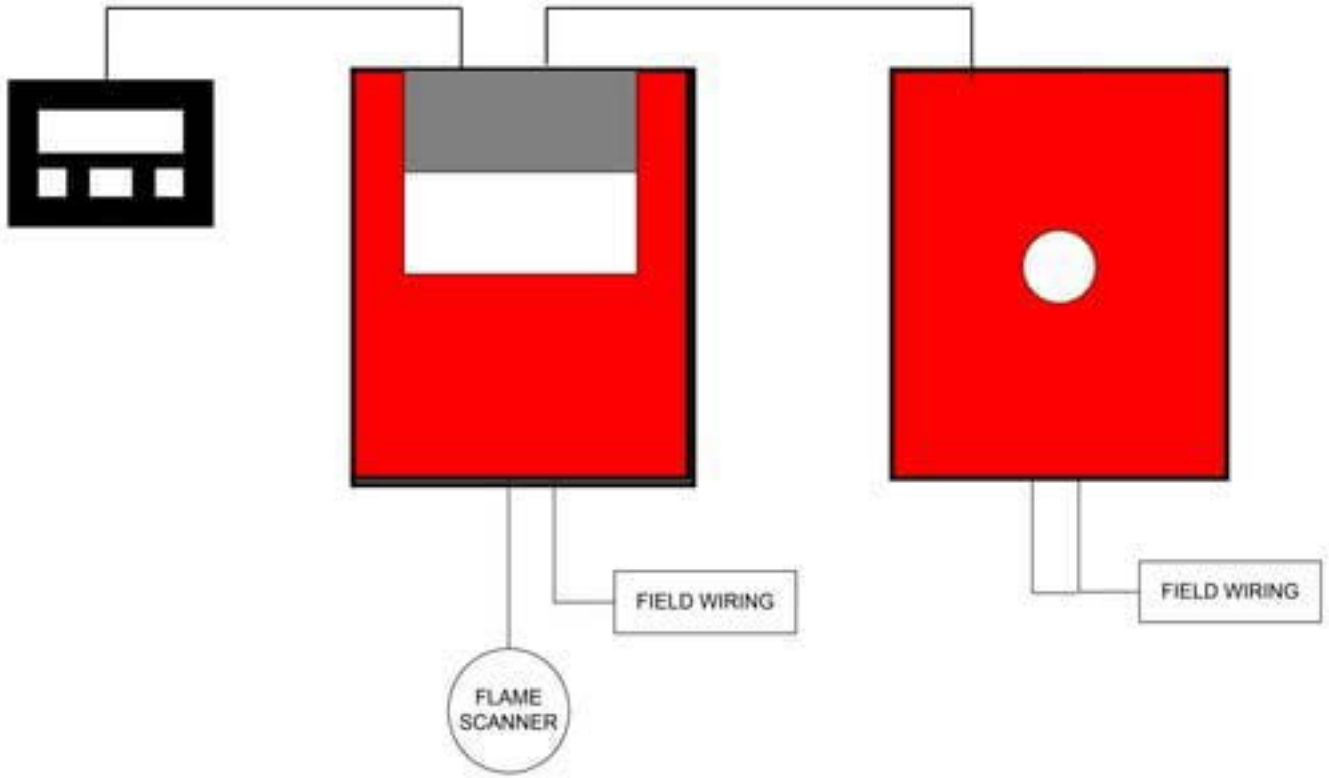
Early Burner Management Systems

- Hardwired Systems
  - Relay and Timer Driven. Found on older installations
  - Typical of Late 50's, 60's
- Solid State Systems
  - Solid State Processors and Relays
  - Found on Systems provided in the 70's and 80's
  - Proprietary Hardware (ie.. Forney and Peabody)
  - Spare Parts are extremely hard to find.

MicroProcessor Based Systems

- Microprocessor Based System providing:
  - Burner Sequencing
  - Ignition
  - Flame Monitoring
- Fixed Program with Limited Configuration Changes
- Components Selected Based on Requirements
  - Programmers, Flame Amplifiers, Message Displays

Fireye™ BMS Layout



MicroProcessor Capabilities

- Simple, Cost Effective
- Features
  - Selectable Flame Amplifiers / Scanners
  - Remote Display
  - Remote Data Communications via Modbus Port
  - Modernization kits are available to integrate with older systems
  - Spare Parts Normally Readily Available

When These Systems are Used

- "Simple" Boiler Installations
  - Packaged Firetube / Watertube Boilers (Steam / Hot Water)
  - Single Burner
  - One Fuel at a Time
  - No Flue Gas Re-Circulation
  - Upgrades from Previous MicroProcessor Based Systems

PLC Based Burner Management Systems

- PLC Based Features
  - NFPA 8501, 8502
  - Watchdog timer
  - UL 508 Certification
- Redundant Scanners
- Logic+ Message Center
  - Shows program status
  - Displays alarms
  - Prompts operator

PLC System Basic Design Features

- Each PLC based burner management system should incorporate a number of design techniques which help detect and act upon unsafe failure modes which can occur in any microprocessor based system. These design features include the following:
  - Critical Input Checking
  - Critical output channel monitoring
  - Electro-mechanical Master Fuel Trip (MFT) Relay
  - Redundant Watchdog Timers
  - Low Water Cut-out Monitoring During Blow Down

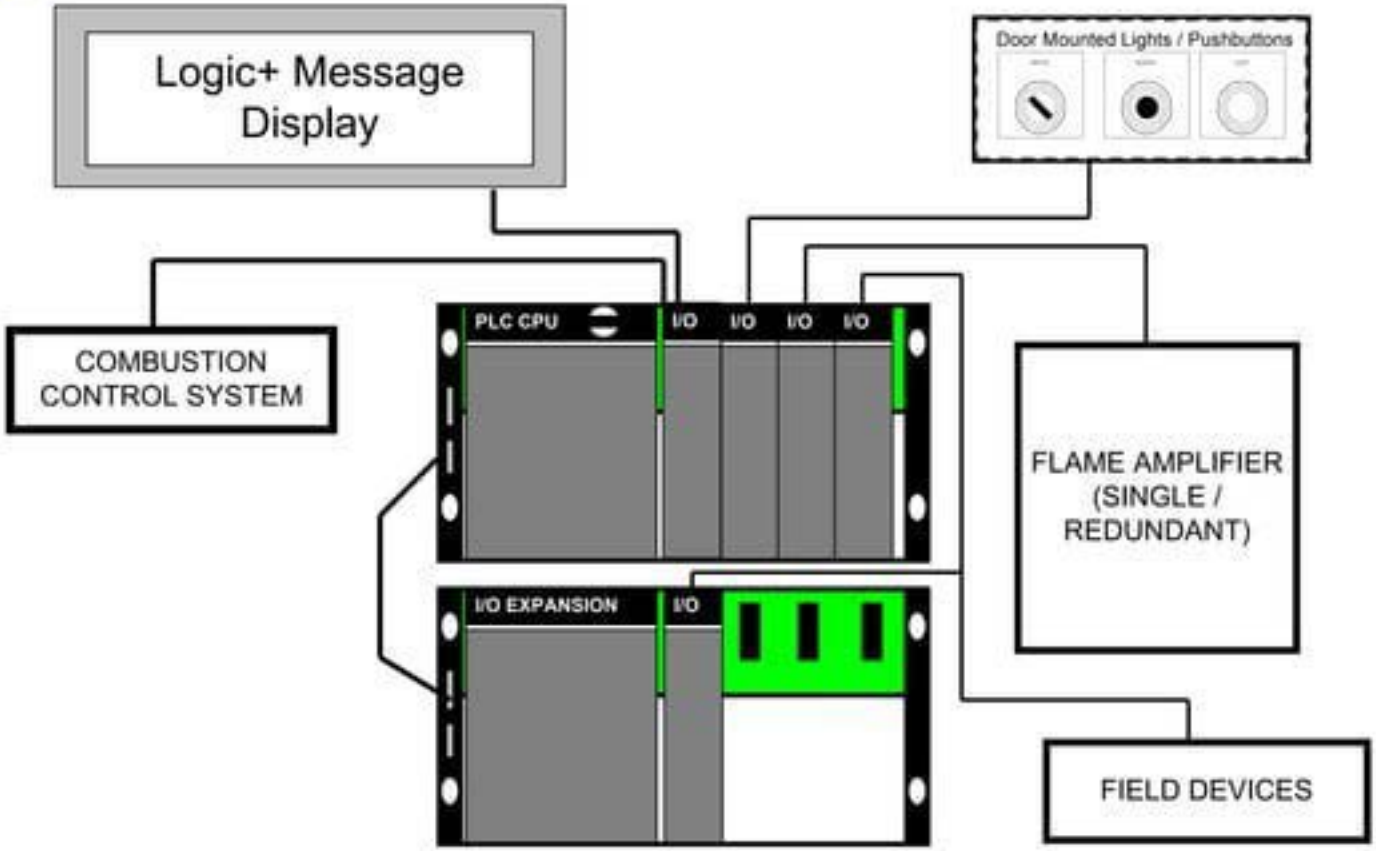
PLC Based System Capabilities

- Provision for Multiple Fuel Firing
  - Capped gas input during curtailment
  - Changeover from gas to oil at any load
  - Simultaneous firing of waste and fossil fuels
- Redundant Scanners, change scanner with fuel
- Single or Multiple Burner Applications
- Integration of BMS with SCADA

PLC Based Operator Interfaces

- Features
  - Clear Written Messages to indicate status, required operator interaction, trip/alarm indication
  - High Visibility through two lines of display
  - Messages reduce time consuming troubleshooting
  - Prioritizes Messages
    - » First Out Alarms
    - » Warning / Alarm Messages
    - » Status Messages / Prompts Operator

PLC System Layout (Typical)



Benefits of PLC Based Systems

- Flexibility / Reliability
  - Programming Software allows changes to system
- Choice of PLCs
  - GE / Modicon / Allen Bradley / Koyo
- Choice of Flame Scanners
  - PPC / Fireye / Honeywell / Iris / Coen
- Application Specific
- Quantity of Burners / Fuels is not restricted

When to Use PLC Based Systems

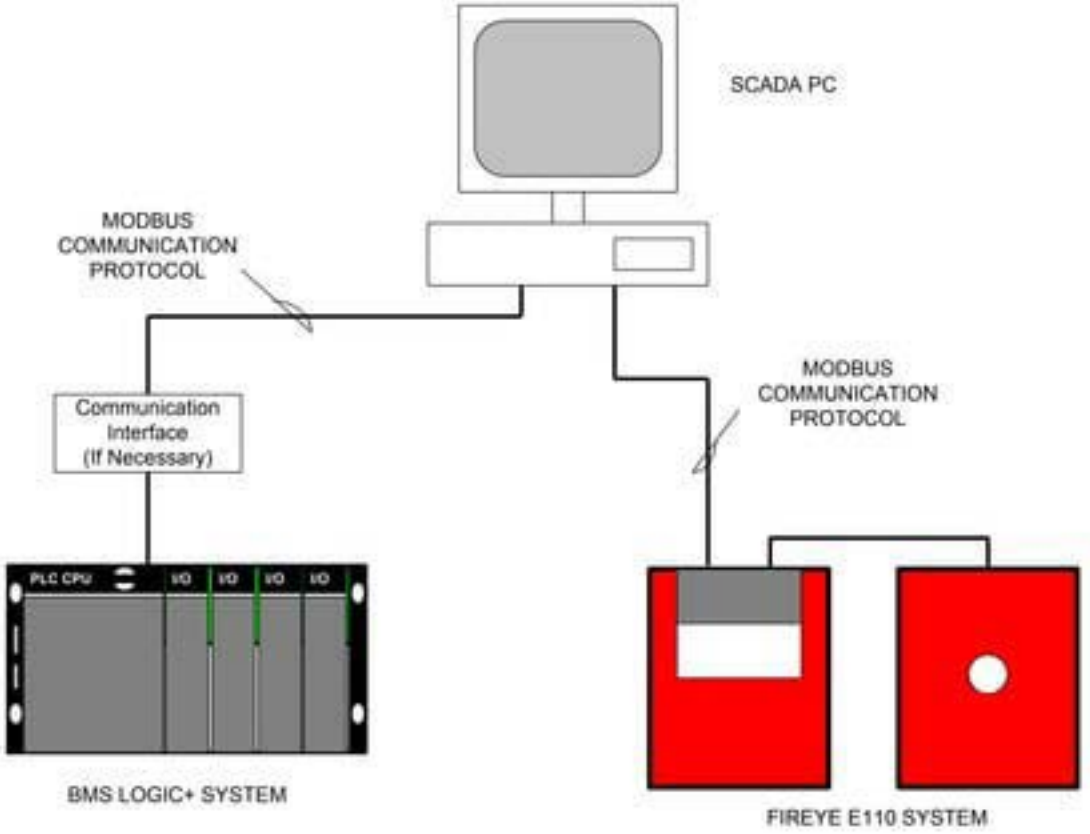
- "Complex" Boiler Installations
  - Larger Packaged Units / Field Erected Units
  - Multiple Burners
  - Multiple Fuels, On-line Fuel Changeovers
  - Flue Gas Re-Circulation
  - Replace Existing Relay Logic Systems
  - Requirement to maintain consistent control platform (spare parts, etc..)

BMS SCADA Interface

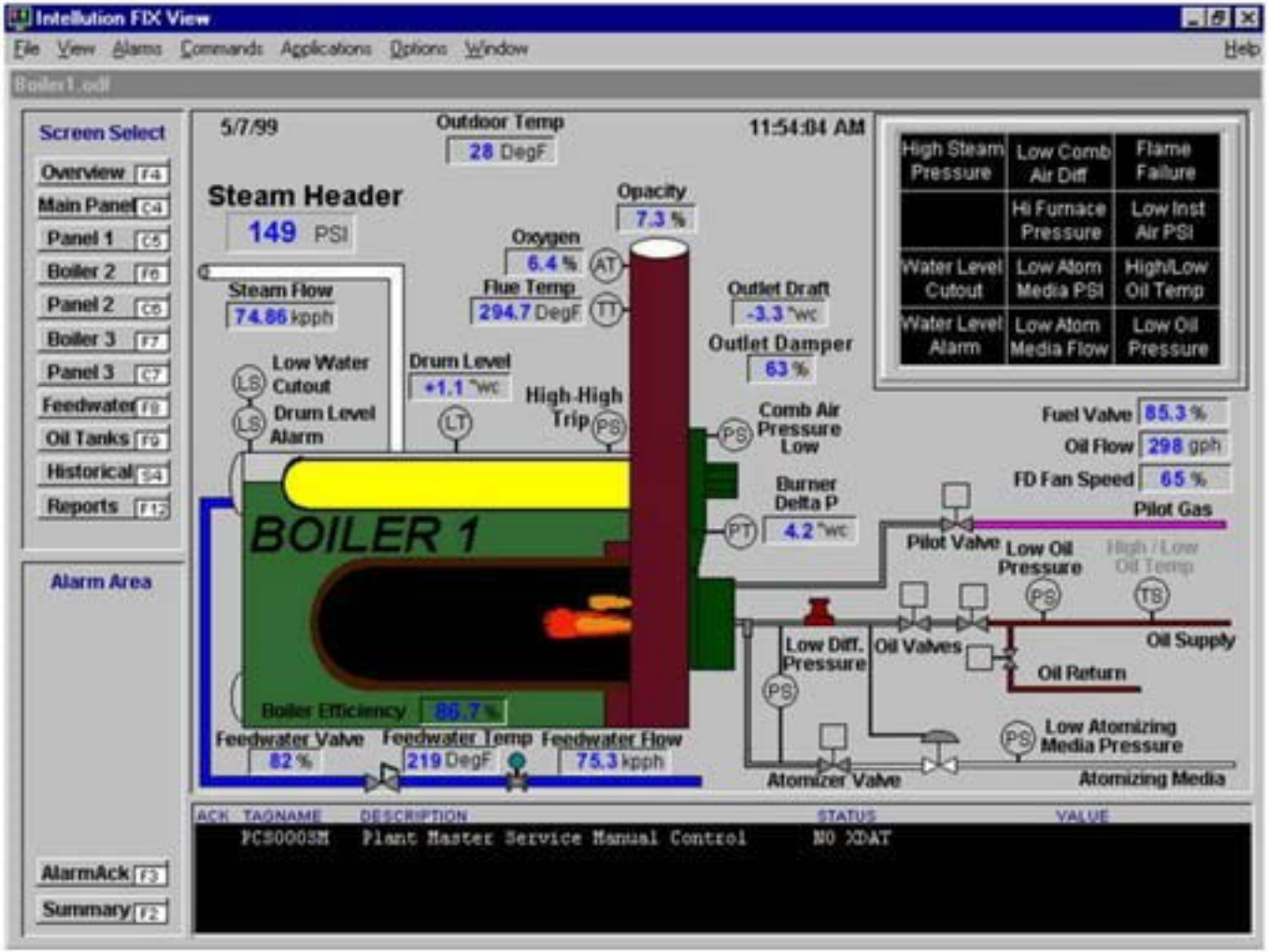
- BMS Systems can be integrated into a SCADA System
  - Allows Remote Monitoring of Flame Status
  - Allows Remote Control of BMS
  - Events (ie.. Burner trip) can be routed to Historical Portion of SCADA for fault evaluation
  - Burner Operation can be trended over time

BMS SCADA Interface

- Interface Methods:



BMS SCADA Interface



Summary

- Benefits Associated with New Burner Management Systems
  - Help Improve plant safety
  - Help qualify for reduced insurance cost
  - Reduce Startup and Down Time with comprehensive alarming and diagnostics

Summary

- Review of Topics Discussed
  - Objectives of Burner Management Systems
  - BMS Design Considerations
  - Basic BMS Logic
  - Types of Burner Management Systems
  - How BMS Systems can be integrated with Plant Wide SCADA Systems