Engineering Standard

SAES-J-602 31 January 2005

Burner Management, Combustion and
Waterside Control Systems for Watertube Boilers

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1 Scope

1.1 This engineering standard establishes minimum requirements for the design, construction and installation of safety systems for single and multiple burner watertube boiler-furnaces.

1.2 This standard applies to the firing of gaseous, vaporized and liquid fuels only, such as natural gas, refinery gas, LPG, and fuel oils, including diesel. For the firing of other fuels, such as by-products derived from NGL processing plants and refineries (e.g., crude waste fuels), prior written approval of the General Supervisor, Process Instrumentation Division, P&CSD, Dhahran, shall be obtained.

1.3 Emphasis is placed on the use of a reliable Burner Management System (BMS), incorporating flame monitoring, safety interlocks, and alarms and trip functions, as detailed in 34-SAMSS-619 and 34-SAMSS-617, and based on SAES-J-601, 34-SAMSS-623, NFPA 85.

1.4 A BMS is considered a specific type of Emergency Shutdown System (ESD). As such, all requirements of SAES-J-601 apply to this standard, except as modified herein.

1.5 All requirements of NFPA 85 apply to this standard.

2 Conflicts and Deviations

2.1 Any conflicts between this Standard and other applicable Saudi Aramco Engineering Standards (SAES's), Materials System Specifications (SAMSS's) Standard Drawings (SASD's), or industry standards, codes, and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Process and Control Systems Department, Dhahran.

2.2 Direct all requests to deviate from this standard in writing to the Company or Buyer Representative, who shall follow internal company procedure SAEP-302 and forward such requests to the Manager, Process and Control Systems Department, Dhahran.

3 References

The latest edition or revision of the following standards, specifications, codes, forms, and drawings shall, to the extent specified herein, form a part of this standard.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

SAEP-302	*Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement*

Saudi Aramco Engineering Standards

SAES-B-006	*Fireproofing*
SAES-F-001	*Process Fired Heaters*
SAES-J-002	*Technically Acceptable Instruments*
SAES-J-003	*Basic Design Criteria*
SAES-J-601	*Alarm, Shutdown and Isolation Systems*
SAES-J-902	*Electrical Systems for Instrumentation*

Saudi Aramco Materials System Specifications

04-SAMSS-051	*Ball Valves, (API SPEC 6D)*
34-SAMSS-512	*Oxygen Analyzers*
34-SAMSS-617	*Flame Monitoring Systems*
34-SAMSS-619	*Burner Management Systems for Watertube Boilers*
34-SAMSS-623	*Programmable Controller Based ESD Systems*
34-SAMSS-716	*Pneumatic Actuators On-Off Service*

Saudi Aramco Library Drawing

DB-950046	*Liquid Level Gauge Glasses Instrument Piping Detail*

3.2 National and Industry Standards

National Fire Protection Association

NFPA 85	*Boiler and Combustion Systems Hazards Code*

American Society of Mechanical Engineers

ASME SEC I	*Boiler and Pressure Vessel Code*

4 Definitions

Automatic: The Saudi Aramco mandatory method of BMS operation in which pushbutton actuations initiate the boiler start-up, with all purging, positioning, timing, and fuel/air valve manipulations occurring automatically. In Automatic BMS logic,

operators are not required to manipulate any burner front controls (e.g., manually open gas cock). Burner starts are actuated from either the local FSS panel or the control house, with the initial burner light off always accomplished locally. Saudi Aramco requires the operator to manually initiate (via pushbutton) each of the following sequences:

- Master Fuel Trip (MFT) reset
- Purge
- Initial ignitor/burner start
- Subsequent ignitor/burner starts and stops
- Boiler normal shutdown

Burner Front Panel: On older supervised manual systems, where the operator must be at the burner front to visually verify and manually perform specific BMS actions during a supervised manual burner light off procedure (e.g., manually open fuel cock), a separate operations panel is required to be located at the burner front. This panel is termed the burner front panel and contains all pushbuttons and indicators needed to initiate the ignitor/burner flame. The burner front panel allows the operator to be at the boiler front to make his equipment manipulations while pushing ignitor/burner start pushbuttons and watching ignitor/burner flame indicators. The burner front panel is distinguished from the flame safety shutdown panel, which is locally mounted but not at the burner front location. Burner front panels are not required on automatic BMS systems.

Burner Management System (BMS): The BMS is the control system dedicated to boiler furnace safety, operator assistance in the starting and stopping of fuel preparation and burning equipment, and for preventing misoperation of and damage to fuel preparation and burning equipment. The BMS includes the following subsystems:

- Logic System
- Field Sensors
- Ignitor System
- Flame Monitoring System
- Fuel Shutoff and Vent Valves
- Local Flame Safety Shutdown Panel
- Control Room Indication and Control Equipment

Master Fuel Trip: Sometimes called main fuel trip or MFT; an event that results in the rapid shutoff of all fuel to a boiler. MFT trip initiators are listed in 34-SAMSS-619.

Safety Shutoff Valve: Also termed block valve, fuel shutdown valve, or SSV valve. An automatic, fast closing, tight shutoff valve that completely shuts off fuel supply to ignitors and burners. These valves are located in the ignitor and burner fuel headers and

in the individual ignitor and burner piping. Safety shutoff valves are used in conjunction with vent valves for gas service. Safety shutoff valves are not emergency isolation or 'ZV' valves and they shall not be provided manual operators, local pushbutton operators, or partial stroke testing features. Safety shutoff valves are under complete control and supervision of the BMS system.

Supervised Manual: A BMS in which a trained operator has primary responsibility for the proper start-up, operation, and normal shutdown of a boiler, with interlocks to ensure that the operation follows established procedures. A supervised manual BMS logic system is distinguished from an automatic system in that the operator must visually verify and manually manipulate some burner front equipment as part of the BMS procedure for each burner startup. Remote burner light-off is not available with a supervised manual system. A burner front panel (in addition to the FSS panel) is required for a supervised manual system. Use of a supervised manual system within Saudi Aramco requires prior written permission from the General Supervisor, Process Instrumentation Division, Process and Control Systems Department.

Vent Valve: A valve used to permit venting air or gas from the ignitor and burner fuel headers and individual ignitor and burner piping. Vent valves are used in conjunction with safety shutoff valves for gas service only. Vent valves are not emergency isolation or 'ZV' valves.

5 General

5.1 Instrument Selection

Instruments shall be selected from SAES-J-002.

5.2 Environmental Conditions

All equipment shall be specified, built and installed for operation in environmental conditions per SAES-J-003.

6 Burner Management Systems

6.1 Electrical Requirements

6.1.1 The electrical installation shall be designed and installed per requirements specified in SAES-J-902.

6.1.2 Power all BMS logic hardware and subsystems from uninterruptable power supplies (UPS), as specified in SAES-J-902 and SAES-J-601.

6.1.3 Voltage levels for BMS logic, subsystems, and auxiliary systems shall be as defined in SAES-J-902 and SAES-J-601.

6.2 Logic System

6.2.1 Logic Hardware Types

6.2.1.1 Triple modular redundant (TMR), programmable logic controllers (PLCs) which are fault-tolerant and fail-safe, shall be used for BMS logic hardware, as specified in SAES-J-601.

6.2.1.2 Solid-state, relay, or other programmable BMS logic hardware, shall not be used.

6.2.2 Logic Software Modification Limitation

BMS logic software shall not be changed while the equipment controlled by the BMS logic is in operation.

6.2.3 Logic Hardware and Software Segregation

A single boiler BMS shall not be integrated with any other BMS or ESD within a single TMR PLC without prior written approval of the General Supervisor, Process Instrumentation Division, P&CSD. Request for approval must be accompanied by a risk assessment report detailing the planned method(s) for:

a) Separation of I/O within BMS hardware.

b) Segregation of independent BMS logic programs.

c) Making logic changes online while meeting the intent of paragraph 6.2.2 above.

d) Effects on the facility from the loss of the TMR PLC.

6.2.4 Logic Sequence

The BMS logic sequence type shall be automatic as defined in section 3. It shall comply with 34-SAMSS-619. A supervised manual logic sequence may not be used without prior written approval of the General Supervisor, Process Instrumentation Division, P&CSD.

6.3 Field Instruments

6.3.1 Input Sensors

6.3.1.1 Input signals to BMS systems may be from discrete, hardwired push/pull buttons, valve position switches, or from analog or digital transmitters, as defined in SAES-J-601.

6.3.1.2 All input sensors and associated signal wiring shall meet the requirements specified in SAES-J-902.

6.3.2 Output Solenoids

Solenoid valves shall have high temperature, class H insulated coils, Viton internal valve trim, and be suitable for continuous duty. They shall meet requirements specified in SAES-J-902.

6.3.3 Input/Output Bypasses

6.3.3.1 Input bypasses shall be provided for each MFT input to the BMS. The input bypasses shall meet the requirements of SAES-J-601. Note that the use of input bypasses is limited to online testing and maintenance only. Startup bypasses are not permitted.

6.3.3.2 Output bypasses may only be used as defined in SAES-J-601.

6.4 Ignitor System

6.4.1 Ignitors

6.4.1.1 Ignitor Types

6.4.1.1.1 Only gas-fired Class 2 (intermittent) or Class 3 (interrupted) ignitors, as defined in NFPA 85, shall be used. Class 1 (continuous) ignitors shall not be used.

6.4.1.1.2 Ignitors shall be the pre-mix type, mixing gas and air in the tip of the ignitor tube to provide a highly stable flame under all loads. Each Class 3 ignitor shall have a heat liberation of approximately 1% of the maximum continuous rating (MCR) of the burner. Each Class 2 ignitor shall have a heat liberation of 4 - 10% of the MCR of the burner.

6.4.1.2 Ignitor Requirements

6.4.1.2.1 Ignitors shall be permanently mounted and located in accordance with burner manufacturer's recommendations. Retractable ignitors may be used. Ignitors shall provide sufficient energy to ignite the specified burner combustible fuel-air mixture reliably.

6.4.1.2.2 The ignitor flame shall be stable with the main burner extinguished and with maximum boiler draft.

6.4.1.2.3 Ignitors shall be capable of immediately igniting their respective burners, even when the ignitor is reduced to the minimum flame capable of energizing the flame-sensing relay.

6.4.1.2.4 Ignitors shall be designed to be placed in service and removed from service without causing a burner or boiler shutdown.

6.4.1.2.5 All ignitors shall be turned off as part of the burner lightoff procedure when the time trial for ignition of the main burner has expired.

6.4.2 Spark Ignition system

6.4.2.1 Each ignitor shall be provided with individual spark ignition.

6.4.2.2 The power supply to the spark ignition system shall be from the BMS uninterruptible power source.

6.4.2.3 The preferred location of the ignition transformer is on the ignitor assembly. When that location is not practical, the transformer may be located in a separate local enclosure.

6.4.3 Ignitor Gas System

6.4.3.1 The ignitor gas supply shall normally be taken from the main fuel gas header, upstream of the main fuel gas header safety shutdown valve. Refer to Figure 1, "Ignitor Gas System Layout."

6.4.3.2 Each boiler shall have a separate ignitor gas header. Ignitor gas to each ignitor shall be supplied from the ignitor gas header. A quick-closing, manual isolating valve shall be provided upstream of all controls, to isolate the ignitor gas supply. This valve shall be used for isolation in an emergency or for maintenance purposes.

6.4.3.3 Filters shall be located upstream of the ignitor gas header safety shutoff valve to prevent entry of foreign material into the ignitor gas system.

6.4.3.4 The ignitor gas header pressure shall be regulated to the designed operating pressure prior to distribution to each individual ignitor subsystem.

6.4.3.5 Both the ignitor header and the individual ignitor double safety shutoff valve and vent valve systems shall operate in the fail safe mode (i.e., upon power failure the safety shutoff valves shall close and the vent valve shall open).

6.4.4 Ignitor Combustion Air System

6.4.4.1 The ignitor combustion air system for each burner shall incorporate the following components, installed in this sequence:

a) Manual isolating (ball) valve
b) Dual-type filter
c) Pressure regulating valve
d) Pressure gauge
e) Two-way direct-acting solenoid valve

6.4.4.2 Ignitor combustion air shall be clean and dry. Ignitors shall not require an external air supply for cooling.

6.5 Safety Shutoff and Vent Valves

6.5.1 Ignitor Safety Shutoff and Vent Valves

6.5.1.1 Either solenoid valves or quarter-turn ball valves may be used for gas ignitor header and individual ignitor shutoff and vent valves.

6.5.1.2 Ignitor solenoid valves shall be two-way, direct-acting valves certified for safety shutoff service in gas fired equipment. Solenoid valves shall be fitted with hermetically sealed or totally encapsulated limit switches detecting the "fully open" and "fully closed" positions for input to the BMS logic system. Solenoids shall have class H, high-temperature insulated coils, and Viton internal trim. They shall be suitable for continuous duty and shall meet the requirements specified in SAES-J-902.

6.5.1.3 Ball valves used as ignitor shutoff and vent valves shall be fire-safe, tight shutoff, quarter-turn ball valves with 316 ss trim. Safety Shutoff valve actuators shall be air open/spring close. Vent valves shall be air close/spring open. Actuators shall

conform to 34-SAMSS-716, "Pneumatic Actuators, On-Off Service."

6.5.2 Burner Safety Shutoff and Vent Valves:

6.5.2.1 Burner header and individual burner safety shutoff and vent valves shall be fire-safe, tight shutoff, quarter-turn ball valves with 316 ss trim. Valves shall conform to Saudi Aramco specification 04-SAMSS-051. Valves in fuel gas service shall incorporate metal seats to prevent sticking.

6.5.2.2 Safety shutoff valve actuators shall be air open/spring close. Vent valves shall be air close/spring open. Actuators shall conform to 34-SAMSS-716, "Pneumatic Actuators, On-Off Service." Manual operation of the safety shutoff and vent valves is not required and neither manual operators, local pushbuttons, or partial stroke testing features shall be provided.

6.5.2.3 Figures 2 through 5 portray minimum requirements for piping and valving.

6.5.2.4 Header Safety Shutoff valves shall close within 10 seconds. Burner Safety Shutoff valves with a nominal size of 4 inch and smaller shall close within 2 seconds. Valves larger than 4 inch shall close within 3 seconds. Vent valves shall open in less than 2 seconds. Opening time of individual burner safety shutoff valves shall be variable in order to be compatible with the burner ignition requirements.

6.5.2.5 All safety shutoff and vent valves shall be fitted with limit switches detecting the "fully open" and "fully closed" positions for input to the logic system. Limit switches shall conform to requirements in 34-SAMSS-716.

6.6 Flame Monitoring System

6.6.1 General

6.6.1.1 Flame monitoring equipment shall be specified in accordance with 34-SAMSS-617.

6.6.1.2 The boiler specification shall specify the type of fuel to be fired in the burner and ignitor. On dual-fuel burners, both the primary and secondary fuels shall be specified.

6.6.1.3 The Vendor of the flame monitoring equipment shall submit in writing, for proponent approval, the proposed detection principle for the specified fuel(s).

6.6.2 Ignitor Flame Supervision

6.6.2.1 The ignitor flame detector shall be installed to:

a) Detect the smallest ignitor flame which can provide smooth and reliable ignition of the main burner

b) Sight the junction of the ignitor flame and the main burner flame

6.6.2.2 The ignitor flame detector amplifier shall provide output signals to indicate the flame intensity and status.

6.6.3 Number of Detectors

6.6.3.1 Two flame detectors minimum per burner (one to sight the junction of the ignitor flame and main burner flame and other to sight the main burner flame only) are required for single-fuel, single or multiple burner boilers.

6.6.3.2 On multiple fuel, single and multiple burner units, two detectors per ignitor/burner are required for the primary fuel. At least one additional detector per burner is required for the burner secondary fuel if the secondary fuel requires a different detector (sighted at the main burner flame only).

6.6.3.3 Where the burner front space is limited and will not allow a third scanner to be fitted, single-element, dual-sensitivity or dual-element (channel) scanners are acceptable.

6.6.3.4 Single-element models shall have automatically selected dual-sensitivity adjustments; one sensitivity adjustment shall be for detecting flame from the ignitor, from gas firing, or from combination firing. The second sensitivity adjustment shall be for detecting flame from oil firing. On dual-element models, each channel shall have separate, independent sensitivity adjustments for the different fuels.

6.6.4 Flame Monitoring System Design

6.6.4.1 The flame monitoring equipment shall be fail-safe in accordance with 34-SAMSS-617.

6.6.4.2 The flame monitoring equipment shall have self-checking features. The cycle time of the self-check function shall be two seconds or less.

6.6.4.3 The equipment and system design shall permit the operator to distinguish between a flame-out signal and self-check fault.

6.6.4.4 On systems utilizing Class 3 ignitors, flame-out signals from both flame detectors of a dual-flame detector system shall be required to trip the associated established (proven) burner, (2 out of 2 voting). A flame-out signal from only one scanner shall activate an alarm in the control room; the fault shall also be indicated on the local flame safety shutdown panel.

6.6.4.5 For systems using Class 2 ignitors which may remain in use during main burner operation, a fault or flame-out on the main flame detector only shall activate an alarm. Any fault or flame-out signal on the detector sighting the ignitor/main flame junction shall initiate a trip of the respective established (proven) burner.

6.6.4.6 A continuous indication of the flame intensity, monitored by each detector, shall be provided near the burner front to facilitate detector sighting. A flame status indicating light shall be located on the local flame safety shutdown panel or burner front panel.

6.6.4.7 The flame-on and flame-off response times for each particular fuel shall be specified in accordance with 34-SAMSS-617.

6.6.4.8 The flame detector shall be suitable for continuous operation in an ambient temperature of 100°C when cooling air is not available. With cooling air, the scanner shall be suitable for continuous operation at 65°C.

6.7 Operator Interface

6.7.1 General

6.7.1.1 Operator interaction with the BMS shall be via a local control panel and, if required, through a remote interface. The local control panel shall be termed the flame safety shutdown (FSS) panel.

6.7.1.2 In systems approved for supervised manual operations, where the operator must be at the burner front to perform specific

actions during the BMS light off cycle (e.g., manually open fuel cocks), a separate burner front panel with all indicators and push buttons required to start-up the ignitor/burner shall be located at each burner front.

6.7.1.3 For automatic BMS logic systems, where the operator is not required to be at the burner front for burner light off, all BMS controls may be operated from the FSS panel.

6.7.1.4 In all cases, the first ignitor and burner must be lit locally. Subsequent ignitor/burner starts may be accomplished from the control room.

6.7.2 Local Flame Safety Shutdown (FSS) Panel

6.7.2.1 The FSS panel shall be located near the boiler front where the operator may generally observe burner and ignitor equipment. However, it is not required to be located at the actual burner front.

6.7.2.2 The FSS panel (and its associated burner front panel, if required), shall have all the necessary pushbuttons and indications to initiate, operate, and trip the BMS independently of any remote operator interfaces.

6.7.2.3 FSS-mounted BMS indicators and controls shall be discrete push buttons and lights, lamps, or LED's hardwired to the BMS logic system. Cathode ray tubes or other non-discrete local operator interfaces may be used in addition to the basic, discrete FSS panel controls.

6.7.2.4 Layout drawings of the FSS panel shall be provided for Proponent approval. These drawings shall detail all the lights or LED's, pushbuttons and indicators which are necessary to monitor the purge permissives, purge, light-off and shutdown conditions and to permit the operator to initiate the burner ignition and firing sequences.

6.7.2.5 The indicators and push buttons shall be displayed in a logical sequence, starting at the top with the permissives, followed by the trip functions, and finally the individual burner start-stop facilities.

6.7.2.6 A dedicated, MFT manual button hardwired to the BMS logic system will be provided at the FSS panel. This button shall be

fitted with an extended guard to prevent accidental operation. The MFT reset push button shall be mounted on the local FSS panel in the purge permissive display area.

6.7.3 Burner Front Panel

6.7.3.1 In approved supervised manual operations where the operator must be at the burner front to perform specific actions during the BMS light off cycle (e.g., manually open fuel cocks or insert oil guns), a separate burner panel with all indicators and pushbuttons required to start-up the ignitor/burner shall be located at each burner front.

6.7.3.2 The burner front panel must have all push buttons and indications necessary to start and stop the ignitors and burners. As a minimum, this will include ignitor ready indicator, start push button, ignitor-on indicator (where ignitor is independently started), and burner ready indicator, start push button, and burner-on indicator. If the burner uses multiple fuels, a fuel selection switch is also required on this panel.

6.7.4 Control Room BMS Operator Interface

6.7.4.1 General

6.7.4.1.1 A control room operator interface may be utilized for either monitoring only or for monitoring and control of the BMS, including remote ignitor and burner light off (subsequent to the first ignitor / burner).

6.7.4.1.2 The control room operator interface for BMS indication and/or control may be either a control panel, (typically termed the control room insert panel) hardwired to the BMS logic system, or an operator workstation, such as a DCS workstation, digitally communicating to the BMS logic system. Digital communication between the BMS and the operator workstation shall meet all requirements of SAES-J-601.

6.7.4.2 Control Room Master Fuel Trip Manual Button

A dedicated, Master Fuel Trip manual button hardwired to the BMS will be provided at the control room operator interface

location. This pushbutton shall be fitted with an extended guard to prevent accidental operation.

6.7.4.3 Control Room Alarms

The burner management system shall have an alarm system that readily identifies and describes each alarm or fault condition, on either an annunciator panel or a CRT/DCS alarm annunciator. The alarm system shall be designed in accordance with SAES-J-601.

6.7.4.4 BMS Sequence of Events Recorder

Each boiler BMS shall have a sequence of events recorder (SOER) that time tags and records all BMS input transitions at a minimum resolution of 100 milliseconds, as per requirements in SAES-J-601. A first-out feature will be included in the SOER for each BMS.

7 Combustion and Steam Demand Control Systems

7.1 Combustion Control Requirements

7.1.1 The combustion control system shall maintain the precise air-fuel ratio at required excess air rate, for all respective fuel(s), under all load conditions. The system shall provide cross-limiting on fuel and air control so that air leads on increasing firing rate and fuel leads on decreasing firing rate.

7.1.2 The combustion control system shall include the provision for setting minimum and maximum limits in the air and fuel control systems to prevent these systems from providing fuel and air flows beyond the stable limits of the burners.

7.1.3 Fuel flow to the burners shall be maintained at the proper rate for light-off by an independent pressure regulator installed in parallel with its respective fuel control valve. See Figures 2 through 5.

7.1.4 The combustion control system design shall provide local and remote indication of all relevant flows, pressures, levels, temperatures and other process or equipment variables.

7.1.5 Combustion air flow shall be measured by differential head venturi or airfoil section. The air flow primary element shall be designed for full flow detection and shall be installed in the forced draft fan inlet or outlet

ducting, upstream of any air heater. Sufficient upstream and downstream straight duct length shall be provided to ensure accurate and repeatable measurements. The differential head element shall be capable of generating at least 10 inches of water column differential at maximum flow. Thermal mass flow sensors and averaging pitot tubes may not be used.

7.1.6 Action of air actuated control valves shall be as follows:

a) Fuel valves shall close on loss of air supply

b) Combustion air drives shall remain in last position on loss of air supply.

7.1.7 A detailed design of the combustion control system shall be submitted by Vendor for review, comment and approval by the Proponent.

7.2 Combustion Quality

7.2.1 Oxygen Analyzer

7.2.1.1 All boilers shall be provided with a flue gas oxygen analyzer and oxygen trim controller to monitor and control the amount of oxygen in the flue gas. The analyzer shall comply with 34-SAMSS-512, "Oxygen Analyzers."

7.2.1.2 Before oxygen trim of excess air is placed on control, idle air dampers/registers shall be closed (except as recommended by the boiler manufacturer). In addition, this will provide a stable flame and prevent fuel rich mixtures of functional burners at low loads.

7.2.1.3 The oxygen trim controller setpoint signal shall be indexed to the boiler load (i.e., steam flow) to provide the correct amount of excess air in accordance with specific load conditions.

7.2.1.4 The oxygen trim control system shall provide for operator bias of both manual and automatic control of the excess air.

7.2.2 Carbon Monoxide Analyzer

7.2.2.1 A carbon monoxide (CO) analyzer shall be used on boilers which operate with low excess air burners (less than ten % above theoretical air requirement) and which use various techniques for the reduction of NOx emissions.

7.2.2.2 CO monitoring is recommended on all boilers.

7.2.2.3 The output of the CO analyzers shall be used for indication and alarm only.

7.2.3 Combustibles Analyzer

Combustibles analyzers are recommended for use on large fuel gas or oil fired boilers as an aid to safe economical operation. The output of combustibles analyzers shall be used for indication and alarm only.

7.2.4 Fuel Gas Calorific Value Analyzer

Where the fuel gas calorific value varies by more than ±10% from the design calorific value, the calorific value of the fuel gas shall be measured continuously. The output signal from the analyzer shall be incorporated into the combustion control system.

7.3 Steam Demand Controls

7.2.1 Steam demand controls, sometimes called Plant Master Control, shall provide the following features for robust response on both load side and supply side upsets:

7.2.1.1 Steam demand control systems shall provide both tradition steam header pressure feedback control and feedforward of steam flow signals. Features and function blocks will be included to eliminate positive feedforward effects due to supply side (fuel BTU) disturbances. Characterization blocks will also be included to model the feedforward to the required demand signal.

7.2.1.2 A multiple output adaptive gain function shall be provided in the Plant Master control system. The multiple output adaptive gain feature shall modify the gain of the Plant Master output demand signal depending on the numbers boiler masters participating in automatic. This gain changer will provide for fast demand response on load side disturbances as well as when boilers are tripped.

8 Waterside Control System

8.1 Boiler Feedwater Control and Isolation Valves

8.1.1 Two parallel, identical control valves shall be provided for feedwater supply to the steam drum. Only one of these valves shall be in service, and it shall be designated as the main (on-line) feedwater control valve.

The other control valve shall be designated as the auxiliary (standby) control valve. Manual means shall be provided to select either valve as the main valve, permitting periodic alternation of control valve service. Feedwater control valves shall remain in their last position (FL) on air supply failure.

8.1.2 A motor operated valve (MOV) shall be located upstream of each of the two feedwater control valves. The MOV control circuits shall provide for both local and control room operation. Each MOV control circuit shall provide both an OPEN and a CLOSED indication in the control room to display valve status. Intermediate position of the MOV shall be indicated by simultaneous activation of both the OPEN and CLOSED indicators.

8.2 Boiler Steam Drum Level Indication and Control

8.2.1 The water level in the steam drum shall be measured by 3 independent transmitters. Transmitters may be water column multipoint conductivity level transmitters, guided wave radar level transmitters, or the differential pressure level transmitters. Each transmitter shall have separate tap points. One of the first two transmitters shall be dedicated to control applications and the second transmitter shall be used for local and control room indication. These two transmitters shall be connected to the same end of the steam drum. The third transmitter shall be used for control room indication of low- and high-level pre-alarms. It shall be mounted on the opposite end of the steam drum from the other two transmitters. Care shall be taken on internal routing of the lower level tap to provide for consistent level signals from all three transmitters.

8.2.2 Each boiler drum shall be fitted with 2 illuminated bi-color level gauge glasses, one at each end. The level gauge shall be double isolated using parallel slide and ball check valves. The installation shall be in accordance with Library Drawing DB-950046 and ASME SEC I Boiler Pressure Vessel Code.

8.3 Boiler Steam Drum High and Low Level Shutdown

8.3.1 Separate high and low steam drum level shutdown transmitters shall be provided.

8.3.2 Each transmitter shall be directly connected to the drum through their own dedicated taps at the same end as the drum level control transmitter. These shutdown transmitters shall be dedicated to shutdown functions only.

9 Installation

9.1 General

9.1.1 Instruments shall be installed in a vibration-free location as close as possible to the point of measurement. Instrument process piping shall be adequately supported to minimize transmission of vibration to the instruments. Access shall be allowed to facilitate testing, calibration and maintenance.

9.1.2 The position of local indicating instruments shall enable them to be observed from grade, platform or walkway while related equipment is operated or when primary instruments are being tested or calibrated.

9.1.3 Instruments and components shall be located so that they are protected against direct drainage or blowdown of condensate, water or process fluids from adjacent equipment.

9.1.4 All locally mounted instrumentation and associated control equipment shall be accessible from grade, platform, fixed walkway or fixed ladder to facilitate testing and maintenance. Where necessary, provide standoff shielding around instrumentation to prevent operator contact with high temperature surfaces, as per requirements in SAES-F-001.

9.2 Electrical

9.2.1 The electrical installation shall comply with SAES-J-902.

9.2.2 It is recommended that separate cable routes be allocated between each boiler and the control room. The routes shall be selected to reduce the loss of plant availability in the event of a fire or explosion, etc. Refer to SAES-B-006 for additional fireproofing requirements.

9.3 Flame Monitoring Equipment

9.3.1 The flame monitoring equipment shall be purchased and installed in accordance with 34-SAMSS-617 and the flame equipment and burner manufacturer's instructions.

9.3.2 Vendor approved cable shall be provided for interconnecting scanners to their respective amplifier/relay units. The layout and wiring techniques shall eliminate or minimize the effects of electrical noise on the flame monitoring equipment.

9.3.3 The location and installation of the scanner shall permit reasonable access for operations and maintenance personnel.

9.3.4 Each scanner shall be installed to permit an unobstructed view of the flame it is supervising under all firing conditions. Scanners should be located or fixed so aim is not disturbed during routine maintenance or burner changes during boiler operation.

9.3.5 The highest UV intensity of gas or oil fired fuels is found in the first 30% of the flame nearest the burner (i.e., the root of the flame). Therefore, the best sighting angle for UV detectors is as near parallel as possible to the axis of the burner flame. The scanner and sight pipe shall be tilted slightly downwards to prevent the build-up of deposits in the sighting pipe or on the scanner lens.

9.3.6 To see as much of the primary combustion zone as possible, flicker/infrared scanners used for oil flame monitoring shall have their sighting angle as near parallel as possible to the center line of the burner.

9.3.7 On multiburner flame monitoring systems, scanners shall be located and angled so that each sees the root of the flame being supervised and as little as possible of any other flames. They shall be sighted so as not to detect the ignitor flame or main flame of any other burner.

9.3.8 UV scanners shall be installed so that they do not sight the ignition spark directly, or indirectly from a reflective surface.

9.3.9 UV scanners shall be shielded from each other to prevent one scanner from affecting the other, (e.g., ultraviolet radiation may be emitted from an UV scanner which is either detecting a flame or is faulty). Special screening (shielding) precautions must be taken when installing scanners which use a photovoltaic cell as a detector and which transmits unamplified signals to its amplifier/relay unit. This type of system is subject to the influence of electrical noise.

9.3.10 To assist in optimum sighting, flame scanners shall be installed on a sight-pipe having a swivel-ball mounting.

9.3.11 If cooling of the scanner is required, this shall be achieved by applying an insulated coupling or adapter and cooling air.

9.3.12 Seal or purge air shall be provided to prevent build-up of deposits of dirt in the sight pipe or on the scanner lens and to allow removal of scanners on pressurized furnaces. A supply of clean (oil/moisture-free) air shall be provided to meet the requirements specified by the flame monitoring equipment manufacturer. Combustion air from the forced draft fan may be used if the pressure, flow, and quality meets the requirements specified by the flame monitoring equipment manufacturer.

10 Testing and Inspection

10.1 BMS Testing

BMS inputs and outputs shall be periodically tested as defined in SAES-J-601.

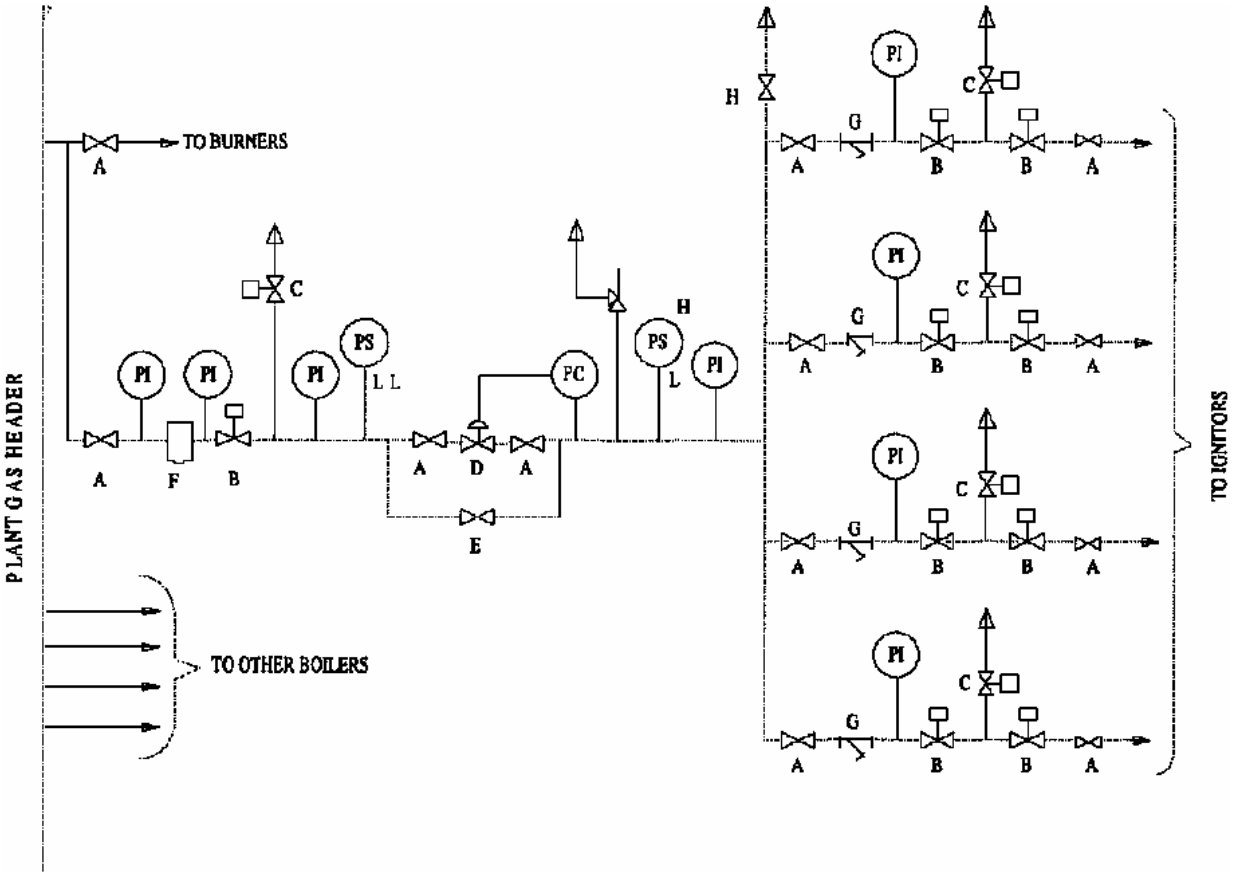
10.2 Safety Shutoff and Vent Valve Testing

The boiler safety system design shall permit the periodic leak testing of fuel safety shutoff block valves and vent valves. Leak testing of main gas fuel header systems shall be accomplished before placing the main header into service. Leak testing of liquid fuel systems shall be accomplished each time the liquid fuel system is placed in service.

Revision Summary

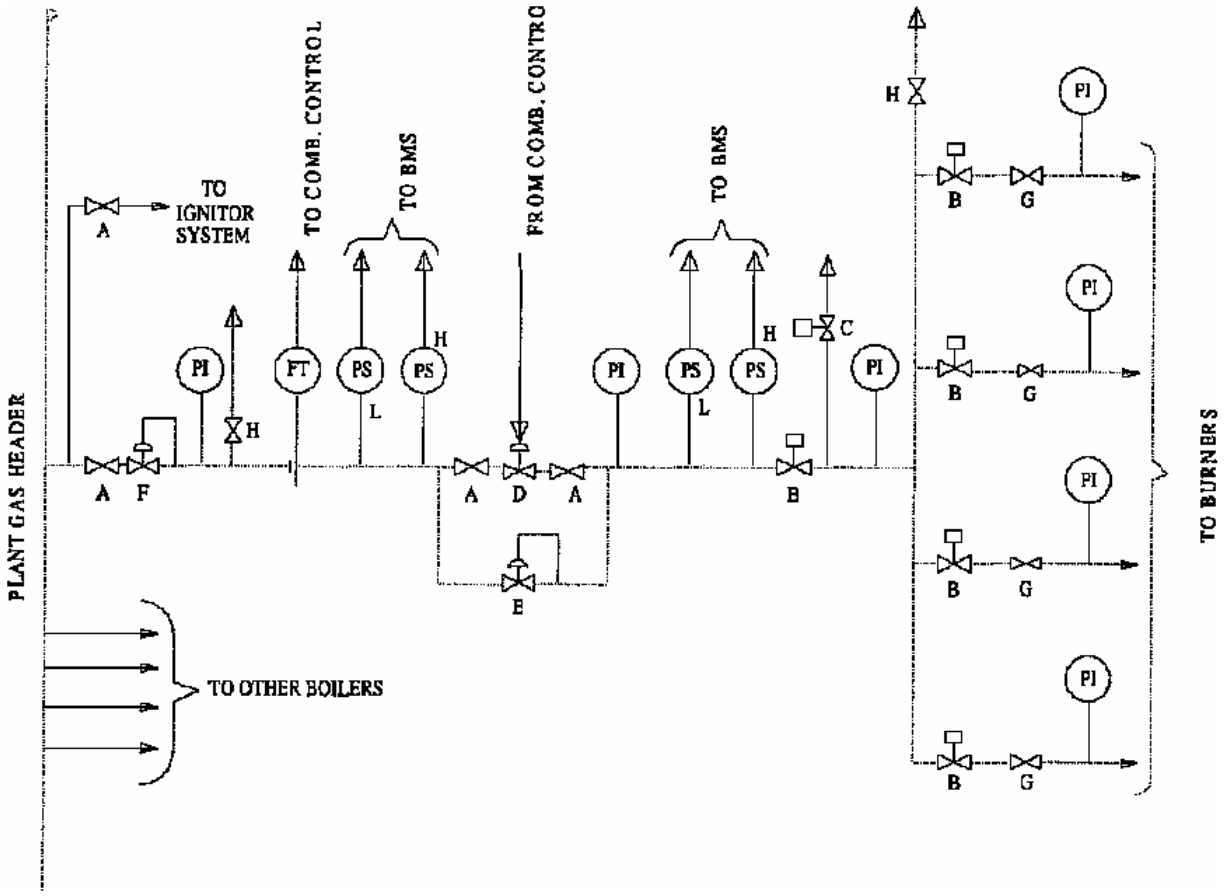
31 January 2005	Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with minor changes.

Figure 1 – Ignitor Gas System



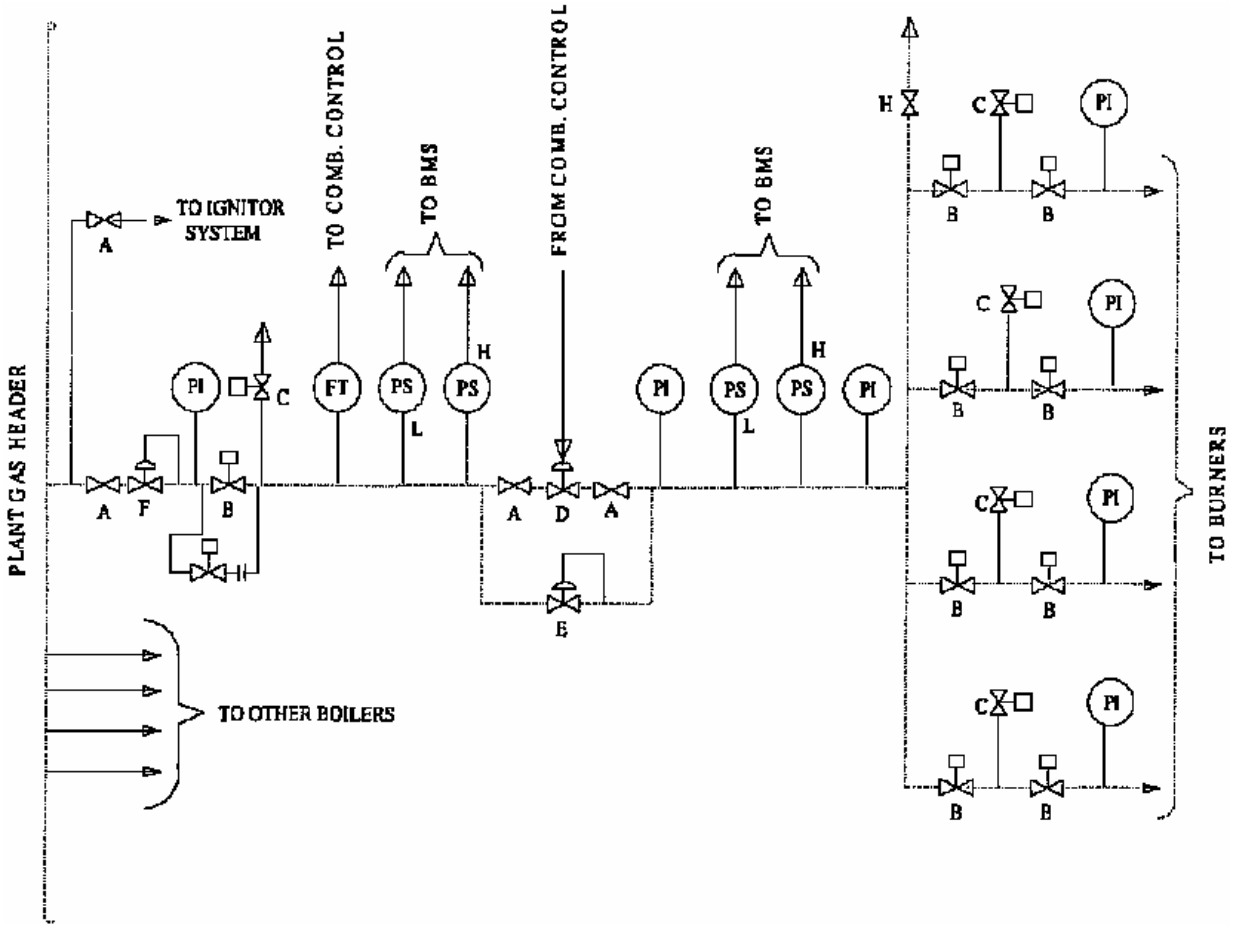
A – Manual Block Valve
B – BMS Operated Safety Shutoff Valve
C – BMS Operated Vent Valve
D – Pressure Control Valve
E – Bypass Valve
F – Filter
G – Strainer
H – Manual Vent Valve
PI – Pressure Indicator (Gauge)
PS – Pressure Switch (or Transmitter)
PC – Pressure Controller

Figure 2 – Gas Burner System (Supervised Manual)



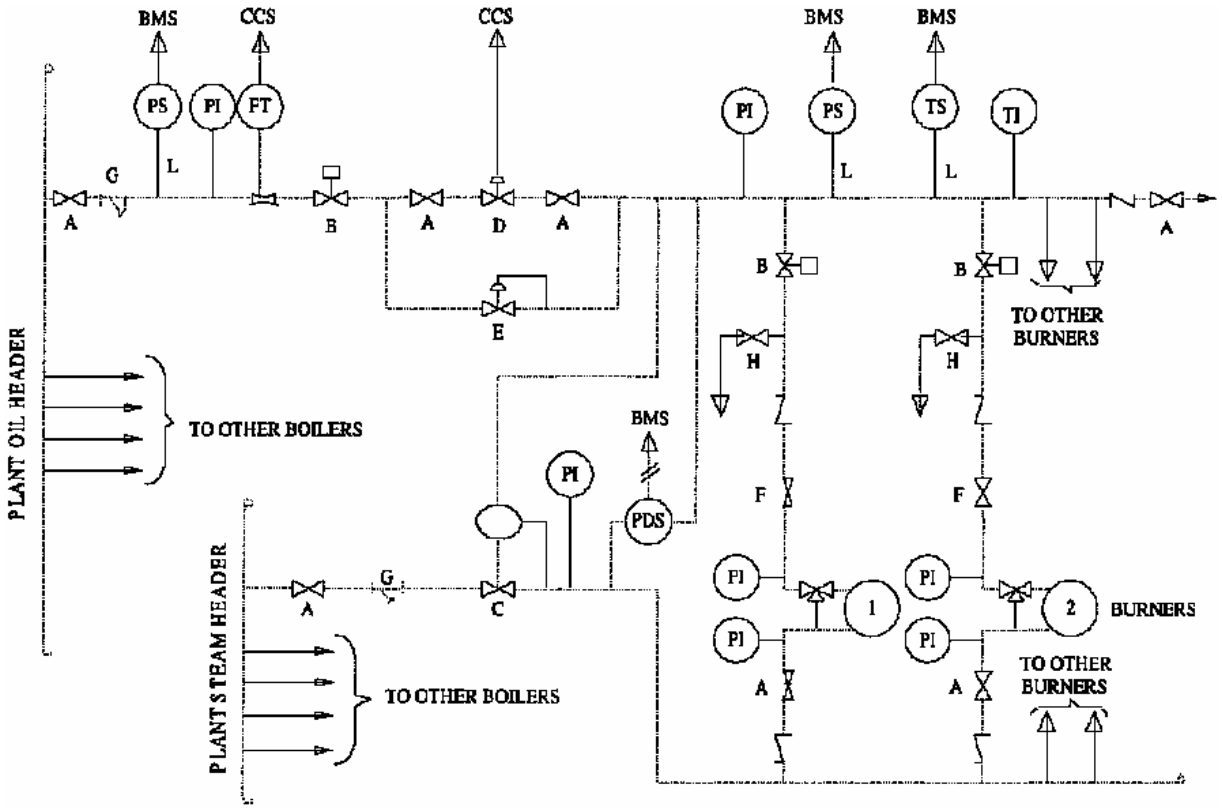
A – Manual Block Valve
B – BMS Operated Safety Shutoff Valve
C – BMS Operated Vent Valve
D – Pressure Control Valve
E – Minimum Flow Regulator
F – Pressure Regulator
G – Manual Supervisory Shutoff Valve
H – Manual Vent Valve
FT – Flow Transmitter
PI – Pressure Indicator (Gauge)
PS – Pressure Switch (or Transmitter)

Figure 3 – Gas Burner System (Automatic)



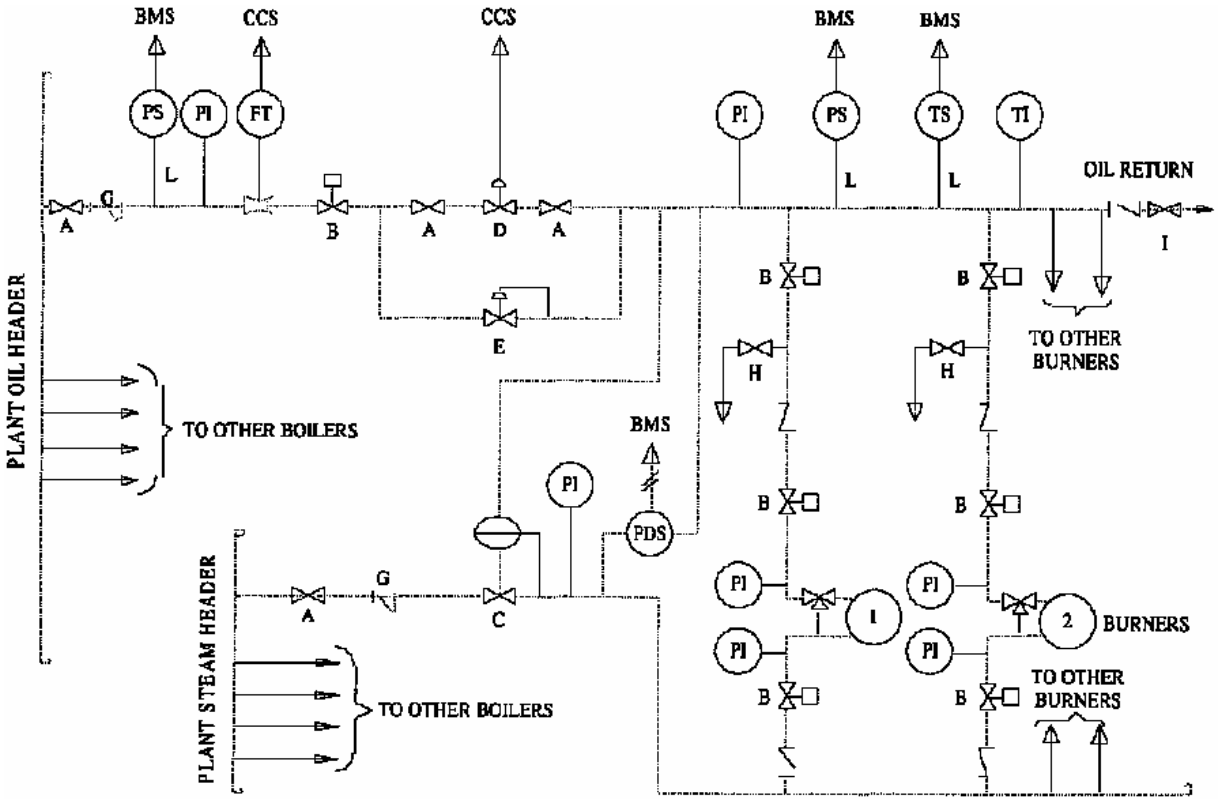
A – Manual Block Valve
B – BMS Operated Block Valve
C – BMS Operated Vent Valve
D – Flow Control Valve
E – Minimum Flow Regulator
F – Pressure Regulator
G – Charging Valve (Optional-Must be Self Closing)
H – Manual Vent Valve
FT – Flow Transmitter
PI – Pressure Indicator
PS – Pressure Switch (or Transmitter)

Figure 4 – Oil Burner System (Supervised Manual)



A – Manual Block Valve
B – BMS Operated Block Valve
C – Steam/Oil Pressure Regulator
D – Flow Control Valve
E – Minimum Flow Regulator
F – Manual Supervisor Shutoff Valve
G – Strainer
H – Manual Bleed Valve
BMS – Burner Management System
CCS – Combustion Control System
PDS – Differential Pressure Switch (or Transmitter)
TS – Temperature Switch
I – Recirculating Valve (Optional for Unheated Oils)
PS – Pressure Switch (or Transmitter)

Figure 5 – Oil Burner System (Automatic)



A – Manual Block Valve
B – BMS Operated Safety Shutoff Valve
C – Steam/Oil Pressure Regulator
D – Flow Control Valve
E – Minimum Flow Regulator
G – Strainer
H – Manual Bleed Valve
BMS – Burner Management System
CCS – Combustion Control System
PDS – Differential Pressure Switch (or Transmitter)
TS – Temperature Switch (or Transmitter)
I – Recirculating Valve (Optional for Unheated Oils)
PS – Pressure Switch (or Transmitter)