SAFETY AND OPERATING CONTROLS TESTING

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My talk today is on safety and operating controls related to steam boilers. All steam boilers regardless of what make or model require safety and control devices to protect and monitor four basic areas: Water, Fuel, Air, and Steam Pressure. It is the function of these controls to supervise and control these elements of a firing boiler. If any of the four elements get out of control boiler explosions and damage to equipment can result. It has been noted by the ASME board (American Society of Mechanical Engineers) that the major perils present in automatically fired boilers are Loss of water, furnace explosions, overpressure, and overtemperature.

I will talk about the principal causes of these perils and how they might be avoided by good practices of installing and testing the safety and operating controls.

I will talk about how the safety and operating controls work with and through the Flame Safeguard control. How this control receives input and sends out output based on the function of the safety controls. The Flame Safeguard control monitors the pre-purge, the pilot ignition, the main flame, and the post purge of the burner to keep it operating safely.

We will look at the basic circuits where these safety controls are found. The Limit Circuit, the Running Interlock Circuit, the Pre-Ignition Interlock Circuit, and the Low Fire Start Circuit.

Finally, I will talk about testing the safety and operating controls, as well as the installation and do and don't of these controls.

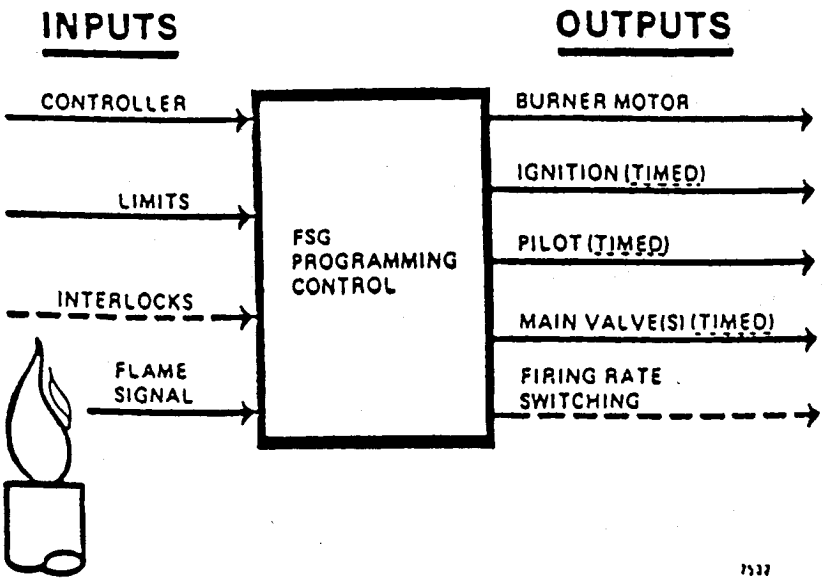
Safety and Operating Controls

1. The major perils present in automatically fired boilers are:

   A. Loss of Water(low water)
   B. Furnace Explosion
   C. Over Pressure
   D. Over Temperature

2. Principal causes of Accidents to automatically fired boilers:

   A. Lack of proper controls & safety devices
   B. Lack of adequate maintenance
   C. Improperly trained operators
   D. Failure to test controls & safety devices
   E. Complacency of operator due to long period of trouble free operation



Sequence of Operation

1. Pre-purge
2. Pilot ignition
3. Main flame
4. Post-purge
5. Refer to programmer booklet for detailed step-by-step sequence

Pre-purge

1. Approximately 45-60 seconds
2. Four complete air changes
3. Clears out combustible gases
4. Prove high & low fire switches
5. Proof running interlock circuit

Pilot Ignition

1. 10 seconds to prove flame
2. Spark, fuel, air, fire
3. Pilot failures due to combustion or electronic causes
4. Combustion causes:
   - Weak transformer
   - Wide electrode gap
   - Too much air
   - Not enough fuel
   - Too small a flame

Plugged or bent scanner tube

5. Electronic causes:
   - Bad scanner cell
   - Bad scanner cable
   - Amp. Circuit bad

Main Flame

1. l0-15 seconds
2. Main fuel valves open
3. Pilot extended 15 seconds to light main flame

Post Purge

1. 15 seconds
2. Main fuel valves close
3. Blower run to purge combustion chamber

Programmer Test

1. Scanner reading - volts or micro amps
2. Test and run switch
3. Check spark intensity
4. Clean contacts on electro mech.
5. Boiler won't start:
   - Limit circuit open
   - Running interlock circuit open
   - Pre-ignition interlocks open

Safety Controls

1. Limit circuit
   - Low water cut off
   - Operating limit control
   - High limit control
   - High gas pressure switch
   - Low gas pressure switch
   - Low oil pressure switch
   - High oil pressure switch
   - Burner on/off switch
   - Oil drawer switch

2. Running interlock circuit
   - Combustjon air proofing switch
   - Atomizing air pressure switch
   - Blower motor starter aux. Switch

3. Pre-ignition interlock circuit
   - Fuel valve proof of closure
   - Oil
   - Gas

4. Purgecircuit
   - High fire switch
   - Low fire proof switch

Safety and Operating Control Testing

When testing all safety or operation controls:

1. Physically make sure the device operates and that it electrically shuts the burner down.

2. Make sure the set point of the device is in the proper control range.

4. Make sure that the switch tested is the only switch that restarts the burner once it is reset.

5. When testing a switch and the set point must be changed in the process of testing, make sure to adjust the switch back to its original operating set point.

Safety and Operating Controls - Installation and Inspection

1. Steam pressure switches
   - A. Do not expose bellows to direct steam.
   - B. Make sure control is level.
   - C. Orient pigtail siphon correctly.
   - D. Clean pressure control bar or manifold.
   - E. Visually check mercury. It should be shiny and mobile, not dull or stringy.

2. Aquastats
   - A Do not mount in lwco crosses.
   - B. Check accuracy.

3. Gas pressure switches
   - A. Do not mount downstream of butterfly.
   - B. Cheek that the switch range fits the actual burner pressure.
   - C. Make sure reset button locks out.

4. Flame scanners
   - A. Shuts down fuel valves in 2-4 seconds.
   - B. Look at fuel valve closure; not flame out in peephole.
   - C. Immunity to hot refractory.

5. Low water cutoff
   - A. Blowing water column cleans bowl and checks wiring circuit.

1) mercury sw. could be oxidized
2) circuit wires shorted.
3) crud bridging across terminals.
4) cleans out mud, crud, and sludge.
5) shuts flame off.

B. Avoid, where possible, piping two lwco into the same pressure vessel tappings.
C. Pull plugs on pipe cross connections.
D. Make sure water column piping is still perpendicular.

6. Combustion air proving switch
A. Remove copper tubing to test.
B. Raise set point above actual air pressure to test.
C. Make sure switch is not wired into the fuel valve circuit.

Limit Circuit

The limit circuit is that series string of operational and safety controls that must be made (closed) before the flame safeguard control will initiate the start up sequence.

Running Interlock Circuit (Lockout Interlock)

The running interlock (lockout interlock) circuit is that series string of safety controls that doesn't have to be made (closed) prior to the start up of the burner, but must make (or close) within10 seconds of the start up of the combustion air fan.

Pre-ignition Interlock (Proof of Closure)

The pre-ignition interlock circuit (a.k.a. the proof of closure circuit) consists of those auxiliary switches tied to the sterns of the motorized fuel valves (gas or oil), which prevent the initiation of the start up sequence of the burner.

Low Fire Start Circuit

The low fire start circuit consists of a switch or switches that will prevent the initiation of the ignition sequence if the burner is not at its normal "light off" position.