NFPA No.

85

EXPLOSION PREVENTION
WATERTUBE BOILER-FURNACES
OIL OR GAS-FIRED (SINGLE BURNER)
1967

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Adopted Jan. 23, 1964. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

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Units of Measurements

Units of measurements used here are U. S. standard. 1 U. S. gallon = 0.83 Imperial gallons = 3.785 liters. One foot = 0.3048 meters. One inch = 25.40 millimeters. One pound per square inch = 0.06805 atmospheres = 2.307 feet of water. One pound = 453.6 grams.

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Standard for

Prevention of Furnace Explosions in Fuel Oil- and Natural Gas-Fired Watertube Boiler-Furnaces with One Burner

NFPA No. 85 — 1967

This standard supersedes the 1965 edition. It was prepared by the Sectional Committee on Industrial Units, approved by the Committee on Boiler-Furnace Explosions and adopted at the 1967 NFPA Annual Meeting on May 17, 1967.

Changes are shown by a vertical line in the margin of the pages on which they appear.

Origin and Development of No. 85

This standard was originally adopted at the 1964 Annual Meeting as NFPA No. 85A and covered natural gas-fired units. At the 1965 Annual Meeting, Tentative Standard NFPA No. 85C-*T* — 1964, covering fuel oil-fired units, was combined with NFPA No. 85A and the combined standard issued as NFPA No. 85.

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SCOPE: The prevention of explosions of pulverized, liquid, and gaseous fuels separately or in combination in industrial and public utility boiler-furnaces, of types designed to produce 10,000 or more pounds of steam per hour. (This field is not covered by the Committee on Dust Explosion Hazards (Standard on Pulverized Fuel), by the Committee on Flammable Liquids (Standard on Oil Burning Equipment), or by the Committee on Fuel Gases (Standard on Gas Appliances and Gas Piping).

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FOREWORD

The Committee on Boiler-Furnace Explosions was organized in 1960 at the request of the American Boiler Manufacturers Association, American Society of Mechanical Engineers, Edison Electric Institute and others, because of concern over the growing hazard to personnel and economic loss from fuel explosions in industrial and public utility boiler-furnaces.

The Committee on Boiler-Furnace Explosions functions with two Sectional Committees. The Sectional Committee on Industrial Units is concerned with watertube boilers ranging in size from 10,000 pounds of steam per hour upward to about 200,000 pounds of steam per hour. The Sectional Committee on Public Utility Units is concerned with public utility units which are generally field erected and range in size from about 200,000 pounds of steam per hour upward.

One of the more difficult parts of the preparation of this Standard was an attempt to define the term "semiautomatic" as it applies to the complete sequence of operation of a watertube boiler. Although the term is commonly encountered, the Committee found that it meant many things to many people and that all thoughts could not be resolved into a definition. Consequently, "semiautomatic" has not been included in this Standard. In its place, the terms "automatic (nonrecycling)" and "supervised manual" have been used. These terms relate to the entire operating sequence and not to the combustion controls alone and are defined in Section 4.

1. INTRODUCTION

11. Fuel explosions concern equipment manufacturers, users and owners of the equipment, and insurance carriers. Personal injury, damage to property and loss of equipment availability demand action to reduce the incidence of these boiler-furnace explosions.

12. It is recognized that advancement in engineering and improvements in equipment may result in operating systems and procedures which differ from those specifically called for in this Standard. Yet, such deviations or improvements may provide desirable safety and compatible operation meeting the intent of this Standard. Such deviations may be accepted when the authority having jurisdiction has made a special investigation of all factors and, based on sound experience and engineering judgment, concludes that the proposed deviations meet the intent of this Standard.

2. CAUSES OF BOILER-FURNACE EXPLOSIONS

21. Furnace explosions occur when sufficient quantities of fuel and air are accumulated in explosive mixtures and then ignited. Ignition energy may be supplied by the regular ignition devices, from another flame envelope, or from other sources within the furnace and boiler passes. Such accumulations of fuel and air can result from: (1) improper operating sequences, (2) inability to ignite fuel as it enters the furnace, and (3) fuel rich or unstable air/fuel ratios. These can result from improper design, application, operating procedures, maintenance, or mechanical failure of equipment components.

3. PURPOSE AND SCOPE

31. The purpose of this Standard is to establish minimum equipment requirements and operating procedures for watertube boiler furnaces, rated at 10,000 pounds of steam per hour and above, and equipped with only one burner. This Standard is to apply to the burning of:

(a) natural gas

(b) fuel oil of No. 2, 4, 5, or 6 grade

(c) Combination natural gas or fuel oil with controls arranged to permit firing only one fuel at a time except as specified in Chapter 8.

Manually operated and automatic units are covered beginning at their service connections.

32. Functional requirements include:

321. The fuel supply

322. The fuel burning system, consisting of:
   (a) The air supply equipment
   (b) The pilot ignition equipment
   (c) The main fuel burner equipment
   (d) The combustion products removal equipment

323. The combustion control system

324. The interlock system, covering:
   (a) Air supply
   (b) Fuel pressure
   (c) Fuel temperature (oil)
   (d) Atomizing medium (oil)
   (e) Flame proving
   (f) Water level
   (g) Steam pressure
   (h) Control system actuating energy
   (i) Combustion products removal

325. Soot blowing

326. Simultaneous firing of oil and gas for fuel transfer.

327. Dual oil atomizers in a single burner.

4. DEFINITIONS

AIR CHANGE — A quantity of air, provided through the burner, equal to the volume of furnace and boiler gas passes. (Air volume to be calculated at 14.7 psia and 70 F.)

AIR/FUEL RATIO

OPTIMUM — A minimum ratio of air to fuel supplied to a furnace which will provide complete combustion of the fuel with sufficient range of excess air to maintain a stable flame envelope.

AIR RICH — A ratio of air to fuel supplies to a furnace which provides more air than that required for an optimum air/fuel ratio.

FUEL RICH — A ratio of air to fuel supplied to a furnace which provides less air than that required for an optimum air/fuel ratio.

AIR-THEORETICAL — The chemically correct amount of air required for complete combustion of a given quantity of a specific fuel.

ALARM — An audible or visible signal indicating an off standard or abnormal condition.

ATOMIZER — That device in an oil burner which emits liquid fuel in a finely divided state, with assistance of an atomizing medium, such as steam or air.

MECHANICAL — That device in an oil burner which emits liquid fuel in a finely divided state without using an atomizing medium.

ATOMIZING MEDIUM — A supplementary fluid, such as steam or air, which assists in breaking down oil into a finely divided state.

BURNER — A device for the introduction of fuel and air into a furnace at the required velocities, turbulence and concentration to establish and maintain proper ignition and stable combustion of fuel within the furnace.

BURNER CONTROL SYSTEMS

AUTOMATIC (Recycling) — A system by which a furnace is purged and a burner is started, ignited, modulated, and stopped automatically and which recycles on a preset pressure range.

AUTOMATIC (Nonrecycling) — A system by which a furnace is purged and a burner is started, ignited, modulated, and stopped automatically but does not recycle automatically.

MANUAL — A system by which a furnace is purged and a burner is started, ignited, modulated, and stopped manually.

SUPERVISED MANUAL — A system by which a furnace is purged and burner is started, and ignited manually, which is modulated automatically, and which is stopped manually, with certain steps and conditions supervised by safety interlocks.

CLEANER — A device to remove foreign matter from fuel.

DRIP LEG — A chamber of ample volume, with suitable clean-out and drain connections, into which gas is discharged so that liquids and solids are trapped.

EXPLOSIVE MIXTURE — A flammable mixture in a confined space.

FUEL OIL — Nos. 2, 4, 5, or 6 fuel oil in accordance with Tentative Specifications for Fuel Oils, ASTM D 396-63T.*

*Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia 3, Pa.

FURNACE — An enclosure for the combustion of fuel.

GAS — (See LP-Gas and Natural Gas.)

HIGH GAS PRESSURE SWITCH — A pressure actuated device arranged to effect a *safety shutdown* of the burner or prevent it from starting when the gas supply pressure exceeds the normal supply pressure by 20 per cent.

HIGH STEAM PRESSURE SWITCH — A pressure actuated device arranged to effect a normal burner shutdown when the steam pressure exceeds a preset pressure.

INERTING — Scavenging of the furnace and boiler gas passes of a fuel rich or unknown gas mixture by dilution with an inert atmosphere.

INTERLOCK — A device which senses a limit or off-limit condition or improper sequence of events and shuts down the offending or related piece of equipment or prevents proceeding in an improper sequence in order to prevent a hazardous condition.

LIGHT-OFF — To establish combustion of fuel entering the furnace.

LIGHT-OFF TIME LIMIT TIMER — A device used on supervised manual systems which limits the allowable time between completion of purge and light-off. This time shall be no more than 5 minutes.

LOW GAS PRESSURE SWITCH — A pressure actuated device arranged to effect a *safety shutdown* of the burner or prevent it from starting when the gas supply pressure falls below 50 per cent of the normal gas supply pressure.

LOW OIL PRESSURE SWITCH — A pressure actuated device arranged to effect a *safety shutdown* of the oil burner or prevent it from starting when the oil supply pressure falls below that recommended by the burner manufacturer.

LOW OIL TEMPERATURE SWITCH — A temperature actuated device arranged to effect the *safety shutdown* of the oil burner or prevent it from starting when the oil temperature falls below the limits required to maintain the viscosity range recommended by the burner manufacturer.

LOW WATER CUTOUT — A device arranged to effect a *safety shutdown* of the burner when water level in the steam drum falls to a predetermined low level.

LP-GAS — A material composed predominantly of any of the following hydrocarbons, or mixtures of them: propane, propylene, normal butane, isobutane and butylenes.

MAIN BURNER ESTABLISHING PERIOD — (See Trial-for-Ignition Period).

MODULATE — To gradually vary the fuel and air flows to the burner in accordance with load demand.

MONITOR — To sense and alarm a condition requiring attention, without initiating corrective action.

NATURAL GAS — A gaseous fuel occurring in nature consisting mostly of a mixture of organic compounds (normally methane, butane, propane, and ethane). The Btu value of natural gases varies between 700 and 1,500 Btu per cubic foot, the majority averaging 1,000 Btu.

NORMAL FUEL SUPPLY PRESSURE — The pressure at the fuel service connection for which the fuel burning system has been designed.

OIL — (See Fuel Oil.)

OPERATING RANGE — The region between the maximum fuel input and minimum fuel input in which the burner flame can be maintained, continuous and stable. This range shall be determined by test.

OUTLET DRAFT — The flue gas pressure at the outlet of the last convection pass of the boiler.

PILOT — A burner smaller than the main burner, which is ignited by a spark or other independent and stable ignition source, and which provides ignition energy required to immediately light off the main burner.

CONTINUOUS — A pilot that burns without turn-down throughout the entire period that the boiler is in service, whether or not the main burner is firing.

INTERMITTENT — A pilot which burns during light-off, and while the main burner is firing, and which is shut off with the main burner.

INTERRUPTED — A pilot which burns during light-off, and which is shut off (interrupted) during normal operation of the main burner.

PILOT ESTABLISHING PERIOD — That interval of time during light-off during which a safety control circuit permits the pilot fuel safety shutoff valve(s) to be opened before the flame safeguard is required to prove the presence of the pilot flame.

PROVE — To establish by measurement or test the existence of a specified condition, such as flame, level, flow, pressure, or position.

PURGE — A flow of air through the furnace, boiler gas passages, and associated flues and ducts which will effectively remove any gaseous combustibles and replace them with air.

RECYCLE — A start-up initiated by steam pressure following a normal shutdown.

REPEATABILITY — The ability of a device to maintain a constant set point characteristic.

RE-START — A manually initiated start-up.

SEMIAUTOMATIC — Not defined. The terms "automatic (non-recycling)" and "supervised manual" have been used to describe the functions conventionally attributed to "semiautomatic."

SERVICE CONNECTION — A point at which fuel, atomizing medium, or power is connected to the boiler, firing equipment, or controlled devices.

SET POINT — A predetermined value to which an instrument is adjusted and at which it shall perform its intended function.

SHUT-DOWN

NORMAL — Stopping burner operation by shutting off all fuel and ignition energy to the furnace.

SAFETY — Stopping burner operation by shutting off all fuel and ignition energy to the furnace by means of a safety interlock or interlocks and requiring a manual re-start.

SOOT BLOWER — A mechanical device for introducing steam or air to clean heat absorbing surfaces.

SUPERVISE — To sense and alarm a condition requiring attention, and initiate corrective action.

TRIAL-FOR-IGNITION PERIOD (MAIN BURNER ESTABLISHING PERIOD) — That interval of time during light-off during which a safety control circuit permits the main burner fuel safety shutoff valves to be opened before the flame safeguard is required to supervise the main burner flame only.

5. EQUIPMENT REQUIREMENTS

51. Fuel Supply (Oil)

511. Fuel shall be properly stored, prepared, and delivered to the oil service connection under anticipated operating conditions in accordance with the applicable portions of NFPA Standard for the Installation of Oil Burning Equipment, No. 31.

512. Operation of the burner shall not be attempted until a satisfactory fuel supply is assured.

5121. Fuel shall be continuously delivered to the combustion chamber in a finely divided form that can be readily ignited and consumed.

5122. All equipment associated with pumping, heating, and straining the fuel from storage to the service connection should be carefully designed, sized, and interconnected to the unit so as to always provide a suitable fuel supply over full range of conditions. Relief valves should be installed after the pump to prevent overpressure in the system.

5123. Fuel being burned shall be delivered to the burner at proper temperature and pressure.

NOTE: Excessively heated oil may create vapor-lock which can prevent continuous operation. Cold oil may prevent satisfactory atomization.

5124. Where the fuel must be heated, care shall be taken to insure that the interlocks and instruments reflect correct values of the variable being measured.

NOTE: It is possible that heavy oil in dead-end lines will tend to solidify. Precautions should be taken to avoid this.

5125. The fuel shall be maintained free from sludge, water or other contaminants that could deposit or result in fuel interruptions or interfere with proper operation of control or measuring equipment.

52. Fuel Supply (Gas)

521. The gas supply at the gas service connection shall be controlled at the pressure for which the fuel burning system has been designed.

522. Gas piping shall be of ample size to maintain the desired constant pressure for the maximum burner flow.

523. Gas shall be free of all foreign matter (solid or liquid). Welding beads, chips, scale, dust and debris shall be removed from the gas piping.

524. A drip leg shall be provided as shown in Appendices A, B, C, G, H and I.

53. Alternate Fuel Firing

531. When oil and gas are to be burned alternately, a manually positioned fuel selector switch shall be provided to permit operation of the necessary interlocks, fuel safety shutoff valves, and controls for the fuel to be fired.

54. Fuel Burning Equipment

541. IGNITION

5411. The main burner shall be equipped with an interrupted or intermittent spark ignited oil or gas pilot as follows:

(a) For burners designed for oil firing only, interrupted pilots shall be used.

(b) For burners designed for gas firing only, interrupted or intermittent pilots may be used.

(c) For burners designed for alternate firing of oil or gas, interrupted pilots shall be used.

5412. The pilot flame shall impinge on the main burner air/fuel mixture and supply sufficient ignition energy to provide immediate ignition of all fuel discharge from the main burner under interlock light-off conditions.

5413. The pilot assembly shall be easily removable for inspection and maintenance.

5414. If LP-Gas pilots are used, special attention is required to materials of construction in valves and their lubrication.

542. MAIN BURNER

5421. The main burner shall direct the fuel and air into the furnace so as to provide a stable flame and efficient combustion over its entire operating range and so that no deposits detrimental to the combustion process will be formed by continuous firing.

5422. The burner shall be provided with at least one convenient observation port of a size to permit satisfactory visual inspection of the pilot and main burner flames.

5423. Any manual adjustment features on the burner shall be provided with positive locking devices.

5424. The atomizing equipment for oil burners shall be designed for convenient removal, cleaning and maintenance.

5425. If an oil burner is equipped with a single atomizer and if provisions for clearing the passages of the atomizer into the furnace are included, such clearing should be done after a normal shutdown with the pilot ignited and the fan operating.

5426. Clearing of the oil passages of the atomizer into the furnace immediately after a safety shutdown shall be prohibited.

543. Atomizing Medium for Oil Burners

5431. When the fuel is to be atomized with the assistance of another medium, this atomizing medium shall be supplied free of contaminants that could cause an interruption of service.

5432. The atomizing medium shall be provided at the pressures required for proper operation.

5433. Provisions shall be made to insure that fuel cannot enter the atomizing medium line during or after operation.

544. Air Supply

5441. The air supply equipment shall be capable of supplying sufficient air for the optimum air/fuel ratio over the entire operating range of the burner.

5442. Provision shall be made for convenient cleaning of the air supply equipment.

545. Main Combustion Chamber

5451. The main combustion chamber shall be designed to promote main burner stability while minimizing zones which cannot be purged.

5452. At least one observation port should be provided to permit observation of the burner flame and furnace.

546. Combustion Products Removal

5461. The outlet draft equipment shall be capable of removing combustion products without adversely affecting stable flame conditions.

5462. If two or more boilers are connected to a common stack, each connection shall be equipped with a damper system. Each damper shall be equipped with operating and locking devices which are readily accessible. This equipment shall be compatible with the combustion control systems of all boilers.

55. Combustion Control System

551. The combustion control system shall modulate and maintain air/fuel mixtures at pre-established optimum air/fuel ratios throughout the entire operating range of the burner and during changes in firing rate.

552. The system shall sense an index of pressure, temperature, or flow and adjust the firing rate accordingly.

553. The system shall provide limits on fuel and air to prevent reducing furnace input below the point of stable burner operation. The minimum and maximum points of stable burner operation shall be defined by the burner manufacturer and verified by operation investigation.

56. Interlock System

561. An interlock system shall be provided to prevent operation under unsafe conditions.

562. The interlocks shall be suitable for the operating system used and shall provide the desired function with high reliability.

5621. Approved equipment shall be used whenever possible.

5622. Each interlock device shall be equipped with a method of readily determining the position of the sensing element switch without having to disassemble any part of the device.

5623. Each interlock shall be provided with a method of securing the set point condition. The set point characteristics shall have a high degree of repeatability within limits that will provide reliable, safe operation.

5624. Interlock devices shall be able to perform under high and low temperature, humidity, vibration, and corrosive ambient conditions.

5625. Interlock devices shall include proper snubbers, time delays, or other means to provide control action consistent with the purposes of this Standard without causing unnecessary shutdowns.

563. The interlock on the low water cut-out may be bypassed for blow down purposes only. This bypass should be of a type which is manually held closed during blow down. For oil firing certain bypassing of interlocks may be necessary for cold starts. See Section 6.

564. No interlocks shall be manually bypassed at any time during normal operation except as provided in 563.

565. Electrical installations shall conform to the National Electrical Code (NFPA No. 70).

5651. Safety control circuits shall be two wire, one side grounded, preferably not exceeding nominal 120 volts and shall be protected with suitable fuses, or circuit breakers.

5652. Switching contacts shall be in the "hot" ungrounded line.

5653. Ungrounded DC control circuits shall have switching

contacts in one side of the line. Ground fault detectors shall be provided.

566. Flame Safety Shutdown System

5661. The time interval between loss of flame and stopping the fuel flow to the burner shall be not more than two seconds.

5662. The fuel safety shutoff valve(s) are the "key unit" of all safety shutdown systems.

5663. Permanent and ready means for making easy, accurate, periodic tightness tests of the main burner fuel safety shutoff valve(s) shall be provided in the piping.

6. METHODS OF STARTING A COLD BOILER

61. In no case shall a boiler be started from a cold condition without a qualified operator being present.

62. For cold start of a boiler normally fired with gas or No. 2 or 4 oil:

621. Follow applicable start-up procedures for the burner control system provided. Firing rate shall be manually limited in accordance with the manufacturer's instructions.

63. For cold start of a boiler normally fired with steam atomizing burner for No. 5 or 6 oil:

631. In the event that frequent starting of a cold boiler becomes necessary without steam available for heating Nos. 5 and 6 oils or as an atomizing medium where required, one of the starting methods described in 632, 633 and 634 should be used.

Note: Other methods have been developed, but their use is not sufficiently widespread to include them.

632. Auxiliary Air Atomizing of Heavy Oil

6321. Equipment Required

(a) Motor driven FD Fan.

(b) Approved auxiliary oil heater for start-up fuel flow with a capacity not less than that required for the flow and temperature through the atomizer required for stable flame.

(c) Compressed air supply.

(d) Check valves in steam and air lines to the atomizer.

6322. Facilities Required

(a) An atomizing air supply piped as shown in Appendices D, E, F, G, H, and I.

6323. Starting Procedure

(a) Circulate and heat oil, using auxiliary heater and recirculating system, to satisfy all interlocks, where included.

(b) Follow normal start-up procedure described in Section 7 using air as the atomizing medium.

(c) Set combustion control in manual position at a low firing rate.

(d) When steam pressure is raised to a point where it is adequate for heating and atomizing the oil, shut down in accordance with the normal shutdown procedure described in Section 7.

(e) Close atomizing air supply and open atomizing steam supply, making certain that dry steam is available.

(f) Change over from auxiliary oil heater to steam oil heater.

(g) Follow normal start-up procedure.

633. Auxiliary Mechanical Atomizing of Heavy Oil

6331. Equipment Required

(a) Motor driven FD fan.

(b) Approved auxiliary oil heater for start-up fuel flow with a capacity not less than that required for the flow and temperature through the atomizer required for stable flame.

(c) Mechanical atomizer.

(d) Means to bypass atomizing medium interlocks. The fact that these are bypassed shall be made evident to the operator with adequate warning devices.

6332. Starting Procedure

(a) Circulate and heat oil using auxiliary heater and recirculating systems to satisfy oil interlocks, where included.

(b) Bypass atomizing medium interlocks, where used.

(c) Insert mechanical atomizer.

(d) Follow normal start-up procedure described in Section 7.

(e) Set combustion control in manual position at a low firing rate.

(f) When steam pressure is raised to a point where it is adequate for heating and atomizing the oil, shut down in accordance with the normal shutdown procedure described in Section 7.

(g) Remove mechanical atomizer.

(h) Insert steam atomizer.

(i) Make atomizing medium interlocks operable.

(j) Change over from auxiliary oil heater to steam oil heater.
(k) Follow normal start-up procedure.

634. AUXILIARY MECHANICAL ATOMIZING OF LIGHT (UNHEATED) OIL

6341. EQUIPMENT REQUIRED

(a) Motor driven FD fan.
(b) Mechanical atomizer.
(c) Check valves in the heavy and light oil lines.
(d) Means to bypass oil and atomizing medium interlocks where used. The fact that these are bypassed shall be made evident to the operator with adequate warning devices.

6342. FACILITIES REQUIRED

(a) Light oil supply.

6343. STARTING PROCEDURE

(a) Shut off heavy oil to system.
(b) Insert mechanical atomizer.
(c) Bypass oil and atomizing medium interlocks.
(d) Open light oil supply into the system.
(e) Follow normal start-up procedure described in Section 7.
(f) Set combustion control in manual position at a low firing rate.
(g) When steam pressure is raised to a point where it is adequate for heating and atomizing the heavy oil, shut down in accordance with normal shutdown procedure described in Section 7.
(h) Shut off light oil supply to the system.
(i) Remove mechanical atomizer.
(j) Insert steam atomizer.
(k) Make oil and atomizing medium interlocks operable by removing bypasses.
(l) Open heavy oil supply to the system.
(m) Follow normal start-up procedure.

7. OPERATING SYSTEMS

71. Section 7 and Appendices A through I illustrate typical arrangements of operating systems for automatic (recycling), automatic (nonrecycling), supervised manual, and manual systems to meet the intent of this Standard. Different arrangements are permissible if they provide equivalent protection and meet the intent of this Standard.

72. Automatic (Recycling) Systems

721. An automatic (recycling) unit shall not be started from a cold condition unless a qualified operator is present. In this section, it is assumed that the unit is hot and that steam pressure and operating water level have been established.

722. It is further assumed that the fuel to be fired has been manually selected. The alternate fuel system shall be placed in a nonfiring position, and the manual burner valve(s) shall be closed.

723. A pilot as specified in 5411 shall be provided.

724. An automatic (recycling) unit shall recycle on a preset pressure and perform four major functions:

(a) pre-firing
(b) light-off
(c) modulation
(d) shutdown

7241. The pre-firing cycle shall accomplish the following in the order listed:

(a) Prove the fuel safety shutoff valve closed. For gas firing, this shall be the downstream valve.

(b) Prove no flame present at the burner.

(c) Start fan.

(d) Satisfy fan interlock.

*(e) Where atomizing medium is used and if not already on, admit medium to main burner.

*(f) Where atomizing medium is used, satisfy atomizing medium interlocks.

*(g) Satisfy appropriate fuel interlocks.

(h) Prove purge air flow by satisfying: (1) air pressure and "open damper" interlocks for all dampers in the flow path

*The order of these items in the sequence is optional.

or (2) air flow interlock. Purge air flow shall reach not less than 70 per cent of the air flow required at maximum continuous capacity of the unit.

(i) The purge shall be sufficient for at least eight air changes. Air flow during the time to open the damper and return it to light-off position may be included in computing the time for eight air changes.

(j) Set controls to light-off position.

(k) Prove dampers and fuel control valve in light-off position.

7242. The light-off cycle for a burner with an interrupted pilot shall accomplish the following in the order listed:

(a) Ignite pilot.

(b) Prove pilot flame within 10 seconds (pilot establishing period).

(1) If proven, admit fuel to main burner. For an oil burner other than return flow type, simultaneously shut off oil recirculating flow.

(2) If not proven, establish *safety shutdown.*

(c) After a maximum of 10 seconds for gas and Nos. 2 and 4 oils or 15 seconds for Nos. 5 and 6 oils, shut off pilot and, with gas pilot, vent the gas piping between pilot safety shutoff valves to atmosphere.

(d) Prove main flame.

(1) If proven, release to modulating control.

(2) If not proven, establish *safety shutdown.*

7243. The light-off cycle for a burner with an intermittent pilot shall accomplish the following in the order listed:

(a) Ignite pilot.

(b) Prove pilot within 10 seconds.

(1) If proved, admit fuel to main burner.

(2) If not proved, establish *safety shutdown.*

(c) Prove main flame within 10 seconds.

(1) If proved, release to combustion control for modulation.

(2) If not proved, establish *safety shutdown.*

7244. Modulation shall be accomplished by a combustion control system.

7245. The normal shutdown cycle shall accomplish the following in the order listed:

(a) Shut off fuel supply to main burner.

(b) For Oil:

(1) Where used, open recirculating valve.

(2) Where used, shut off atomizing medium, if desired.

(c) For Gas:

(1) Interrupt spark and shut off gas to pilot if in operation.

(2) Vent gas piping between safety shutoff valves to atmosphere.

(d) Shut down fan, if desired.

7246. High steam pressure shall accomplish a normal shutdown, and the burner shall be allowed to recycle when steam pressure has dropped to within the preset operating range.

7247. The *safety shutdown* cycle shall accomplish the following in the order listed and activate an alarm:

(a) Shut off fuel supply to main burner.

(b) Shut off fuel supply and interrupt spark to the pilot if in operation.

(c) For Oil:

(1) Where used, open recirculating valve.

(2) Where used, shut off atomizing medium, if desired.

(d) For Gas:

(1) Vent gas piping between safety shutoff valves to atmosphere.

(e) Where used, energize inerting system simultaneously with (a) above.

(f) Shut down fan, if desired.

(g) Lock out sequence control to require manual reset.

7248. The following conditions shall accomplish a *safety shutdown*, and the burner shall not be allowed to recycle without manual reset until a qualified operator determines the cause of the shutdown and takes the necessary corrective action to assure that safe operating conditions prevail before restarting:

(a) For Oil:

(1) Under pressure in the fuel supply at the service connection.

(2) Under temperature of Nos. 5 and 6 oils.

(3) Loss of combustion air supply.
(4) Loss of or failure to establish flame.
(5) Loss of control system actuating energy.
(6) Power failure.
(7) Low water level.
(8) Loss of atomizing medium, where used, as interlocked by (1) flow or (2) two pressure switches, one located at the service connection and the other at the burner, either one of which shall establish a safety shutdown on under pressure.

(b) For Gas:
(1) Over or under pressure in the gas supply at the service connection.
(2) Loss of combustion air supply.
(3) Loss of or failure to establish flame.
(4) Loss of control system actuating energy.
(5) Power failure.
(6) Low water level.

Caution — Excessive recycling to achieve a burner light-off can lead to accumulation of a hazardous amount of fuel in the furnace and shall be avoided.

73. Automatic (Nonrecycling) Systems

731. The provisions of 721, 722, 723, and 724 shall apply except for 7246 (see 7311).

7311. When high steam pressure establishes a normal shutdown, the burner shall not be allowed to recycle. A qualified operator shall initiate the re-start.

74. Supervised Manual Systems for Oil

741. The following steps shall be taken by the operator when starting a supervised manual unit and the indicated interlocks shall be satisfied at each step. It is assumed that fuel pressure and temperature, atomizing medium, control system energy, power, and water level have been established. When interlocks have been satisfied, this fact shall be indicated to the operator.

742. Select the fuel to be fired. The alternate fuel system shall be placed in a nonfiring position, and the manual burner valve(s) shall be closed.

743. A pilot as specified in 5411 shall be provided.

744. Prefiring Cycle

Operator Functions	Interlock Functions
(a) Check manual fuel shutoff valve(s) closed.	(a) Manual fuel shutoff valve closed.
(b) Start fan.	(b) Fan on.
(c) Where used, open atomizing medium valve.	(c) Atomizing medium supply available.
(d) Open damper(s) to purge position.	(d) (1) Air pressure and open damper(s), or (2) Air flow.
(e) Start purge timer.	(e) Purge complete.
(f) Place damper and fuel control valve in light-off position.	(f) Damper and fuel control valve in light-off position. If light-off air flow is less than purge air flow rate, start light-off time limit timer.
(g) None.	(g) Spark and pilot and main safety shutoff valves operable.

745. Light-off Cycle

Operator Functions	Interlock Functions
(a) Close recirculating valve, where used.	(a) None.
(b) Start pilot ignition system.	(b) Prove pilot. If air flow is less than purge air flow rate, pilot shall be proven within 10 seconds.
(c) Open fuel safety shutoff valve to main burner.	(c) None.
(d) Open manual fuel shutoff valve.	(d) Prove main flame within 10 seconds for Nos. 2 and 4 oils or 15 seconds for Nos. 5 and 6 oils. Close pilot safety shutoff valve(s). For gas pilot, vent gas piping between safety shutoff valves.
(e) Bring unit to preset operating pressure at an acceptable rate, maintaining an optimum air/fuel ratio.	(e) None.
(f) On reaching preset pressure range, change to automatic combustion control.	(f) None.

746. NORMAL SHUTDOWN CYCLE

Operator Functions	Interlock Functions
(a) Shut off fuel supply to the main burner.	(a) Fuel safety shutoff valve(s) to main burner closed.
(b) Open fuel recirculating valve, where used.	(b) None.
(c) Where used, shut off atomizing medium.	(c) None.
(d) Remove fuel atomizer.	(d) None.
(e) Shut down fan if desired.	(e) None.

747. SAFETY SHUTDOWN CYCLE

Operator Functions	Interlock Functions
(a) None.	(a) Shut off fuel supply to the main burner and shut off fuel supply and interrupt spark to the pilot if in operation.
(b) None.	(b) With gas pilot, vent gas piping between safety shutoff valves to atmosphere.

748. The following conditions shall accomplish a *safety shutdown.*

(a) Under pressure in the fuel supply at the service connection.
(b) Loss of combustion air supply.
(c) Loss of or failure to establish flame.
(d) Loss of control system actuating energy.
(e) Power failure.
(f) Low water level.
(g) Loss of atomizing medium.

749. The following condition shall sound an alarm:

(a) Low oil temperature.

Caution — Excessive recycling to achieve a burner light-off can lead to accumulation of a hazardous amount of fuel in the furnace and shall be avoided.

75. Supervised Manual Systems for Gas

751. The following steps shall be taken by the operator when starting a supervised manual unit and the indicated interlocks shall be satisfied at each step. It is assumed that control system energy, power, and water level have been established. When interlocks have been satisfied, this fact shall be indicated to the operator.

752. Select the fuel to be fired. The alternate fuel system shall be placed in a nonfiring position, and the manual burner valve(s) shall be closed.

753. A pilot as specified in 5411 shall be provided.

754. PREFIRING CYCLE

Operator Functions	Interlock Functions
(a) Check gas safety shutoff valves closed.	(a) Gas safety shutoff valves closed.
(b) Start fan.	(b) Fan motor on.
(c) Open damper(s) to purge position.	(c) (1) Air pressure and open damper(s), or (2) Air flow.
(d) Start purge timer.	(d) Purge complete.
(e) Place damper and gas control valve in light-off position.	(e) Damper and fuel control valve in light-off position. If light-off air flow is less than purge air flow rate, start light-off time limit timer.

755. LIGHT-OFF CYCLE

Operator Functions	Interlock Functions
(a) Start pilot ignition system.	(a) Prove pilot. If air flow is less than purge air flow rate, pilot shall be proved within 10 seconds.
(b) Open gas safety shutoff valves to main burner.	(b) Prove main flame within 10 seconds.
(c) Bring unit to preset operating pressure at an acceptable rate, maintaining an optimum air/fuel ratio.	(c) None.
(d) On reaching preset pressure range, change to automatic combustion control.	(d) None.

756. NORMAL SHUTDOWN CYCLE

Operator Functions	Interlock Functions
(a) Shut off gas supply and interrupt spark to the main burner and to the pilot if in operation.	(a) Vent gas piping between safety shutoff valves to atmosphere.
(b) Shut down fan if desired.	(b) None.

757. SAFETY SHUTDOWN CYCLE

Operator Functions	Interlock Functions
(a) None.	(a) Shut off gas supply to the main burner and shut off fuel supply and interrupt spark to the pilot if in operation. Where used, simultaneously energize inerting system.
(b) None.	(b) Vent gas piping between safety shutoff valves to atmosphere.

758. The following conditions shall accomplish a *safety shutdown*:

(a) Over or under pressure in the gas supply at the service connection.
(b) Loss of combustion air supply.
(c) Loss of or failure to establish flame.
(d) Loss of control system actuating energy.
(e) Power failure.
(f) Low water level.

Caution — Excessive recycling to achieve a burner light-off can lead to accumulation of a hazardous amount of fuel in the furnace and shall be avoided.

76. Manual Systems

761. While the requirements and functions in Nos. 71, 72, 73, 74 and 75 are essential to safe operation, it is recognized that with adequate and uninterrupted supplies of fuel and air, certain operating functions can be performed by a qualified operator as well as by control devices. However, the provisions of 7611, 7612, 7613, 7614 and 7615 shall be observed.

7611. A pilot as specified in 5411 shall be provided.

7612. Manual shutoff valve(s) shall be provided in the fuel line(s) adjacent to the burner. For gas firing, this shutoff valve shall be proved closed before the spark to the pilot can be energized and the pilot and main gas safety shutoff valves can be opened.

7613. Changes in firing rate shall be made by simultaneous adjustment of the fuel and air supplies at a pre-established optimum air/fuel ratio. This shall be accomplished by the manipulation of only one control device.

7614. Provide limits on fuel and air to prevent reducing furnace input below the point of stable burner operation. The minimum and

maximum points of stable burner operation shall be defined by the burner manufacturer and verified by operating investigation.

7615. The following interlocks shall be included to accomplish a *safety shutdown*:

(a) For oil, under pressure in the fuel supply at the service connection.

(b) For gas, over and under pressure in the fuel supply at the service connection.

(c) Loss of combustion air supply.

Caution — Excessive recycling to achieve a burner light-off can lead to accumulation of a hazardous amount of fuel in the furnace and shall be avoided.

77. Soot Blowing

771. Soot blowing is necessary to maintain high thermal efficiency in oil-fired boilers. However, if this operation is not performed with optimum air/fuel ratio, explosions may occur from the formation and ignition of air-soot dust clouds within the boiler.

7711. Operate soot blowers only while burners are firing at rates sufficiently high to avoid extinguishing the burner flame.

7712. Boilers equipped with automatic soot blowing equipment shall have their controls interlocked to prevent operation when the burner is shut down or in the prefiring or light-off cycles.

8. SIMULTANEOUS FIRING OF OIL AND GAS FOR FUEL TRANSFER

81. Under certain conditions, due to steam demand, transfer from one fuel to another without stopping the flow of fuel to the furnace may be necessary.

811. Certain equipment and procedures are required to avoid developing a hazardous condition.

812. Under these conditions, it is imperative that the change-over be accomplished in a manner to prevent a fuel-rich condition.

813. A qualified operator shall make the transfer.

82. Fuel transfer when a combustion control system meters and total inputs from both gas and oil fuels, alone or in any combination, and controls air flow proportionally (preferred method).

821. EQUIPMENT REQUIRED

8211. A burner capable of burning the two fuels simultaneously during the transfer period.

8212. A fuel transfer switching system which includes the following features:

(a) A gas position in which oil cannot be fired.

(b) An oil position in which gas cannot be fired.

(c) A gas-oil position which permits simultaneous firing of both fuels provided all interlocks for both fuels are satisfied.

8213. A combustion control system which meters and totals inputs from both gas and oil fuels, alone or in any combination, and controls air flow proportionally.

822. PROCEDURE FOR CHANGING FROM ONE FUEL TO THE OTHER.

8221. This procedure must be compatible with the specific equipment which makes up the combustion control system. Following the manufacturer's instructions and verify the procedure with operating tests.

83. Fuel transfer when combustion control system is suitable for firing only one fuel at a time (alternate method).

831. EQUIPMENT REQUIRED

8311. A burner capable of burning the two fuels simultaneously during the transfer period.

8312. A fuel transfer switching system which includes the following features:

(a) A gas position in which oil cannot be fired.

(b) An oil position in which gas cannot be fired.

(c) A gas-oil position which permits simultaneous firing of both fuels provided all interlocks for both fuels are satisfied, including light-off position for both fuels.

8313. Manual shutoff valves at the burner and downstream of the safety shutoff valves in each fuel line.

8314. A pressure gage in each fuel line downstream of the manual shutoff valve.

832. PROCEDURE FOR CHANGING FROM GAS TO OIL

(a) If an intermittent pilot is available, place it in service.

(b) Check that the manual oil valve at the burner is closed.

(c) Establish oil fuel system to satisfy interlocks.

(d) Install oil atomizer.

(e) Open atomizing medium shutoff valve.

(f) Place oil control valve in the normal light-off position.

(g) Place fuel transfer switching system into oil-gas position.

NOTE: If the oil safety interlocks are satisfied, the oil safety shutoff valve will open. Fuel oil pressure now will be upstream of manual oil valve at the burner.

(i) Observe the gas pressure downstream from the manual gas shutoff valve and slowly close valve until the gas pressure starts to drop.

NOTE: At this point the gas flow rate is controlled by the manual valve instead of by the normal control valve.

(j) Simultaneously and slowly close the manual gas valve while operating the manual oil valve to light the oil flame from the gas flame. Continue to increase oil firing rate while cutting back on gas firing rate to keep a constant heat input of the combined fuels to the burner until the manual gas valve is closed and manual oil valve is fully open. Care must be taken to maintain an adequate amount of excess air at all times by continuously observing the burner flame, or by observing the fuel-air ratio or oxygen indicator, if provided.

NOTE: It should be emphasized that during this period, air flow is maintained at a constant rate, with only the manual fuel valves operated.

(k) Place the fuel transfer system in the oil position.

NOTE: The gas safety shutoff valves will now close.

(l) Return the combustion control system and burner firing rate to normal operation.

833. PROCEDURE FOR CHANGING FROM OIL TO GAS

(a) If an intermittent pilot is available, place it in service.

(b) Check that the manual gas valve at the burner is closed.

(c) Establish gas fuel system to satisfy interlocks.

(d) Place combustion control system in manual position.

(e) Place fuel transfer switching system in the gas-oil position.

NOTE: If the gas safety interlocks are satisfied, the gas safety shutoff valves will open. Gas pressure now will be upstream of gas manual valve at the burner.

(g) Observe the oil pressure downstream from the manual oil shutoff valve and slowly close valve until the oil pressure starts to drop.

NOTE: At this point the oil flow rate is controlled by the manual valve instead of by the normal control valve.

(h) Simultaneously and slowly close the manual oil valve while operating the manual gas valve to light the gas flame from the oil flame. Continue to increase gas firing rate while cutting back on oil firing rate to keep a constant heat input of the combined fuel to the burner until the oil valve is closed and manual gas valve is fully open. Care must be taken to maintain an adequate amount of excess air at all times by continuously observing the burner flame, or by observing the fuel-air ratio or oxygen indicator, if provided.

NOTE: It should be emphasized during this period, air flow is being maintained at a constant rate, with only the manual fuel valves operated.

(i) Place the fuel transfer system in the gas position.

NOTE: The oil safety shutoff valve will now close.

(j) Return the combustion control system and burner firing rate to normal operation.

9. DUAL OIL ATOMIZERS IN A SINGLE BURNER

91. When a burner is equipped with main and auxiliary oil atomizers for the purpose of changing atomizers for maintenance without affecting the boiler load, care must be taken to prevent a fuel-rich condition during the changeover period.

911. This changeover should be carried out under stable firing conditions.

912. A qualified operator shall perform this transfer operation.

92. The procedure outlined in 921 through 926 is recommended.

921. Install auxiliary atomizer.

922. Slowly open atomizing medium valve to auxiliary atomizer until pressure reaches that required for light-off.

923. Slowly close manual fuel valve on main atomizer until it is in control of oil flow.

924. Slowly open the manual valve admitting oil to the auxiliary atomizer until it ignites.

925. Divert the atomizing medium and oil flow from the main atomizer to the auxiliary atomizer until the main atomizer is out of service.

926. To place a main atomizer back into service and to remove auxiliary atomizer, repeat 921 through 925.

10. INSPECTION AND MAINTENANCE

101. Since the effective operation of all safety and control devices depends upon their ability to respond quickly to their activating impulses, it is important that they be in proper operating condition at all times. Systematic and thorough inspection and maintenance are necessary.

102. An inspection and maintenance schedule shall be set up on a periodic basis.

1021. Any defects found shall be corrected immediately.

1022. During initial operation, more frequent inspection, adjustment, cleaning, etc., will be required.

103. It is essential that individuals making inspections be thoroughly familiar with all operating procedures and equipment functions and be capable of rendering sound judgment as to when equipment is in reliable operating condition.

104. Minimum Schedule:

1041. DAILY

(a) Check flame failure detection system.

(b) Test low water level cutout and alarm.

1042. WEEKLY

(a) Check pilot.

1043. MONTHLY

(a) Test all fan and air pressure interlocks.

(b) Check main burner safety shutoff valve(s) for leakage.

(c) Check low fire start switch.

(d) For Oil:

(1) Test fuel pressure and temperature interlocks.

(e) For Gas:

(1) Check gas cleaner and drip leg.

(2) Test high and low fuel pressure switches.

1044. SEMIANNUALLY

(a) Inspect burner components.

(b) Check flame failure system components, such as vacuum tubes, amplifier, and relays.

(c) Check piping and wiring of all interlocks and shutoff valves.

(d) Recalibrate all indicating and recording gages.

1045. ANNUALLY

(a) Replace vacuum tubes, scanners, or flame rods in the flame failure system.

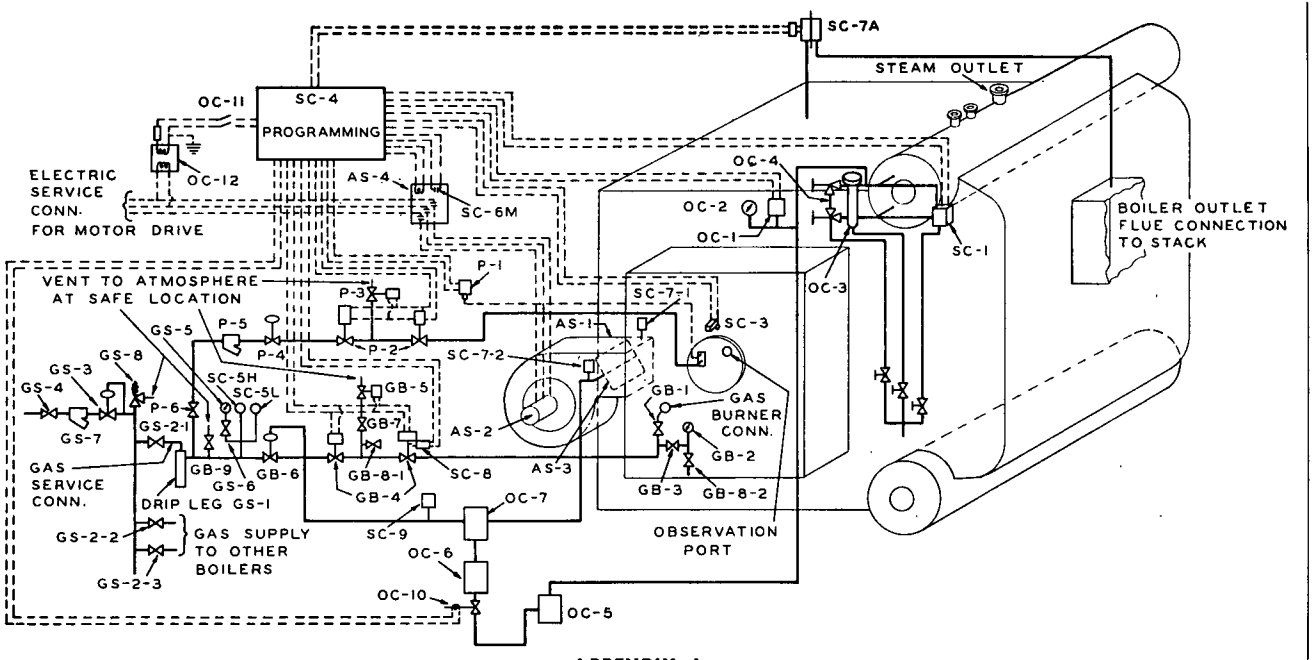
(b) Test all coils, diaphragms, and other operating parts of all safety shutoff and control valves.

(c) Recondition low water cutout.

1046. AS REQUIRED FOR OIL FIRING

(a) Remove and clean atomizers.

(b) Clean oil strainers.



APPENDIX A

NATURAL GAS FIRING ONLY

Typical Schematic Arrangement of Safety Equipment
Natural Gas-Fired Watertube Boiler with One (1) Burner
Automatic (recycling) or Automatic (nonrecycling) Controls

APPENDIX A — LEGEND

Gas Supply System:

GS-1 Drip leg
GS-2-1 Manual plug cock, required only when single pressure reducing valve serves more than one boiler
GS-3 Gas supply pressure reducing valve
GS-4 Manual gas supply shut-off valve
GS-5 Gas supply pressure gage
GS-6 Gas supply pressure gage cock
GS-7 Gas cleaner
GS-8 Relief valve

Air System:

AS-1 Forced draft fan
AS-2 Forced draft fan motor
AS-3 Forced draft fan control damper at inlet or outlet
AS-4 Forced draft fan motor starter

Pilot System:

P-1 Pilot ignition transformer
P-2 Safety shut-off valves, auto. opening, spring closing (NC)
P-3 Vent valve, auto. closing, spring opening (NO)
P-4 Gas pressure regulating valve optional depending on pilot pressure requirements
P-5 Gas cleaner
P-6 Manual plug cock

Gas Burner System:

GB-1 Manual plug cock
GB-2 Gas burner pressure gage
GB-3 Gas burner pressure gage cock
GB-4 Safety shut-off valves, auto. opening, spring closing (NC)
GB-5 Vent valve, auto. closing, spring opening (NO)
GB-6 Gas fuel control valve
GB-7 Vent line manual plug cock (locked or sealed in open position)
GB-8-1 Leakage test conn. upstream safety S.O. valve
GB-8-2 Leakage test conn. downstream safety S.O. valve
GB-9 Manual plug cock for venting high pressure from supply when required

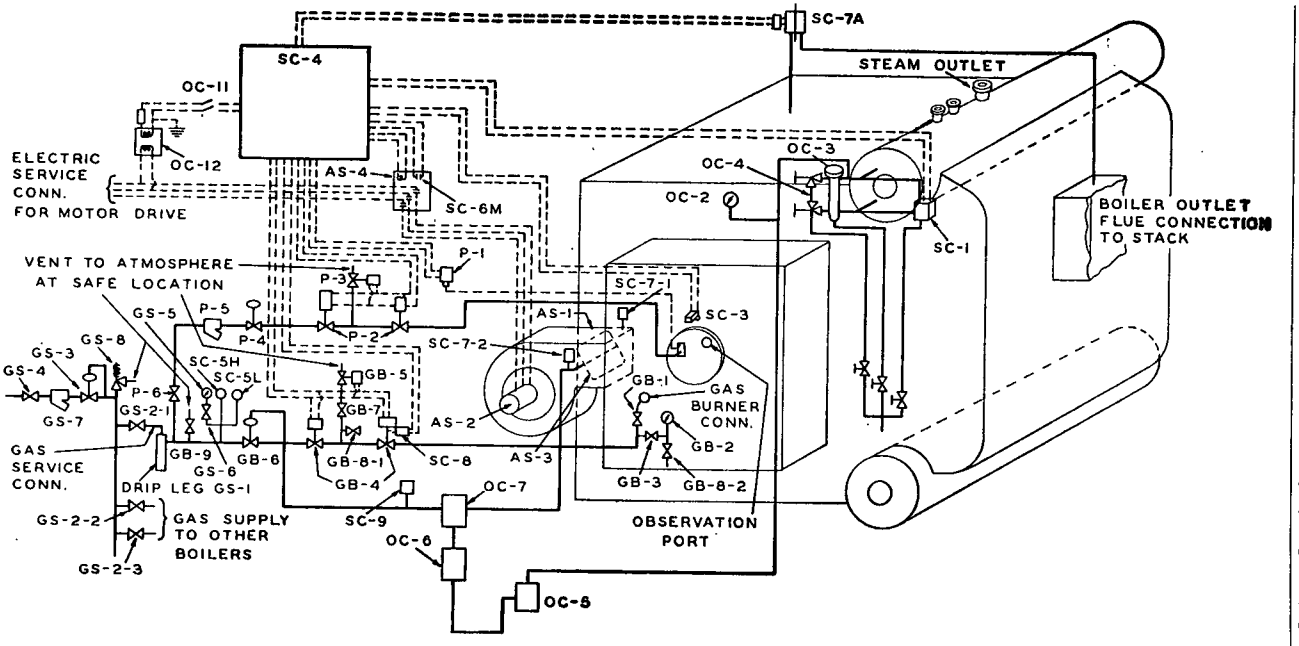
Safety Controls: (All switches in "hot" ungrounded lines. See 5652)

SC-1 Low water cut out integral with column or separate from water column
SC-3 Flame scanner
SC-4 Program controller (contains lights, switches, relays, timers, etc.)
SC-5H Gas supply high pressure switch
SC-5L Gas supply low pressure switch
SC-6M Loss of air supply aux. contact in motor starter
SC-7-1 Windbox pressure switch (note 2)
SC-7-2 Fan damper position switch (note 2)
SC-7A Purge A.F. switch (note 2)
SC-8 Closed position interlock on GB-4
SC-9 Light-off position interlock

Operating Controls & Instruments:

OC-1 High steam pressure switch (note 1)
OC-2 Steam drum pressure gage
OC-3 Water column with high & low level alarms
OC-4 Water gage and valves
OC-5 Steam pressure controller
OC-6 Manual auto. selector station
OC-7 Combustion control drive unit or units
OC-10 Modulating control low fire start positioner
OC-11 Manual operating switch
OC-12 Control transformer

NOTES: 1. With automatic (non-recycling) control an overpressure shutdown requires manual restart.
2. Purge airflow may be proved by providing either SC-7-1 and SC-7-2 (and similar devices for other dampers which are in series) or SC-7A.



APPENDIX B

NATURAL GAS FIRING ONLY

Typical Schematic Arrangement of Safety Equipment
Natural Gas-Fired Watertube Boiler with One (1) Burner
Supervised Manual Controls

Gas Supply System:

GS-1 Drip leg
GS-2-1 Manual plug cock, required only when single pressure reducing valve serves more than one boiler
GS-3 Gas supply pressure reducing valve
GS-4 Manual gas supply shut-off valve
GS-5 Gas supply pressure gage
GS-6 Gas supply pressure gage cock
GS-7 Gas cleaner
GS-8 Relief valve

Air System:

AS-1 Forced draft fan
AS-2 Forced draft fan motor
AS-3 Forced draft fan control damper at inlet or outlet
AS-4 Forced draft fan motor starter

Pilot System:

P-1 Pilot ignition transformer
P-2 Safety shut-off valves, auto. opening, spring closing (NC)
P-3 Vent valve, auto. closing, spring opening (NO)
P-4 Gas pressure regulating valve optional depending on pilot pressure requirements
P-5 Gas cleaner
P-6 Manual plug cock

Gas Burner System:

GB-1 Manual plug cock
GB-2 Gas burner pressure gage
GB-3 Gas burner pressure gage cock
GB-4 Safety shut-off valves, spring closing (NC)
GB-5 Vent valve, auto. closing, spring opening (NO)
GB-6 Gas fuel control valve
GB-7 Vent line manual plug cock (locked or sealed in open position)
GB-8-1 Leakage test conn. upstream safety S.O. valve
GB-8-2 Leakage test conn. downstream safety S.O. valve
GB-9 Manual plug cock for venting high pressure from supply when required

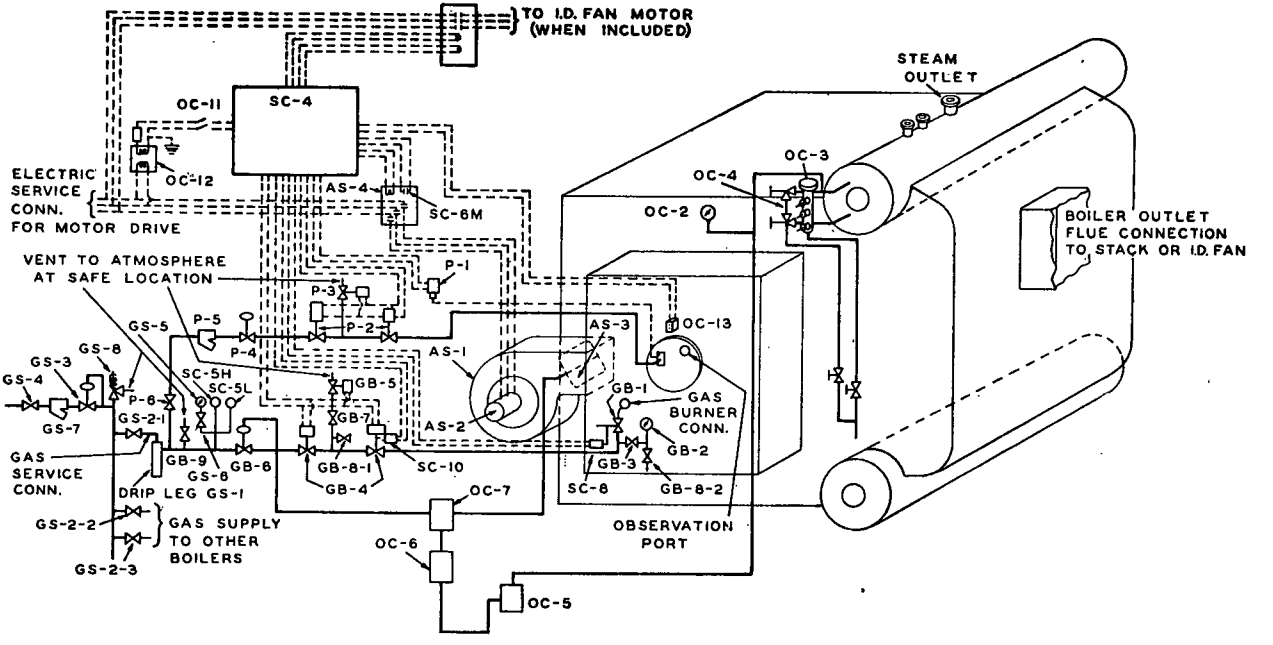
Safety Controls: (All switches in "hot" ungrounded lines. See 5652)

SC-1 Low water cut out integral with column or separate from water column
SC-3 Flame scanner
SC-4 Control cabinet (contains lights, switches, relays, timers, etc.)
SC-5H Gas supply high pressure switch
SC-5L Gas supply low pressure switch
SC-6M Loss of air supply aux. contact in motor starter
SC-7-1 Windbox pressure switch (note 1)
SC-7-2 Fan damper position switch (note 1)
SC-7A Purge A.F. switch (note 1)
SC-8 Closed position interlock on GB-4
SC-9 Light-off position interlock

Operating Controls & Instruments:

OC-2 Steam drum pressure gage
OC-3 Water column with high & low level alarms
OC-4 Water gage and valves
OC-5 Steam pressure controller (optional)
OC-6 Manual auto. selector station (included if OC-5 furnished)
OC-7 Combustion control drive unit or units
OC-11 Manual operating switch
OC-12 Control transformer

NOTE: 1. Purge airflow may be proved by providing either SC-7-1 and SC-7-2 (and similar devices for other dampers which are in series) or SC-7A.



APPENDIX C

NATURAL GAS FIRING ONLY

Typical Schematic Arrangement of Safety Equipment
Natural Gas-Fired Watertube Boiler with One (1) Burner
Manual Controls

Gas Supply System:

GS-1 Drip leg

GS-2-1 Manual plug cock, required only when single pressure reducing valve serves more than one boiler

GS-3 Gas supply pressure reducing valve

GS-4 Manual gas supply shut-off valve

GS-5 Gas supply pressure gage

GS-6 Gas supply pressure gage cock

GS-7 Gas cleaner

GS-8 Relief valve

Air System:

AS-1 Forced draft fan

AS-2 Forced draft fan motor

AS-3 Forced draft fan control damper at inlet or outlet

AS-4 Forced draft fan motor starter

Pilot System:

P-1 Pilot ignition transformer

P-2 Safety shut-off valves, auto. opening, spring closing (NC)

P-3 Vent valve, auto. closing, spring opening (NO)

P-4 Gas pressure regulating valve optional depending on pilot pressure requirements.

P-5 Gas cleaner

P-6 Manual plug cock

Gas Burner System:

GB-1 Manual plug cock

GB-2 Gas burner pressure gage

GB-3 Gas burner pressure gage cock

GB-4 Safety shut-off valves, spring closing (NC)

GB-5 Vent valve, auto. closing, spring opening (NO)

GB-6 Gas fuel control valve

GB-7 Vent line manual plug cock (locked or sealed in open position)

GB-8-1 Leakage test conn. upstream safety S.O. valve

GB-8-2 Leakage test conn. downstream safety S.O. valve

GB-9 Manual plug cock for venting high pressure from supply when required

Safety Controls: (All switches in "hot" ungrounded lines. See 5652)

SC-4 Control cabinet (contains lights, switches, relays, timers, etc.

SC-5H Gas supply high pressure switch

SC-5L Gas supply low pressure switch

SC-6M Loss of air supply aux. contact in motor starter

SC-8 Closed position interlock on GB-1

SC-10 Open position interlock on GB-4

Operating Controls & Instruments:

OC-2 Steam drum pressure gage

OC-3 Water column with high & low level alarms

OC-4 Water gage and valves

OC-5 Steam pressure controller (optional)

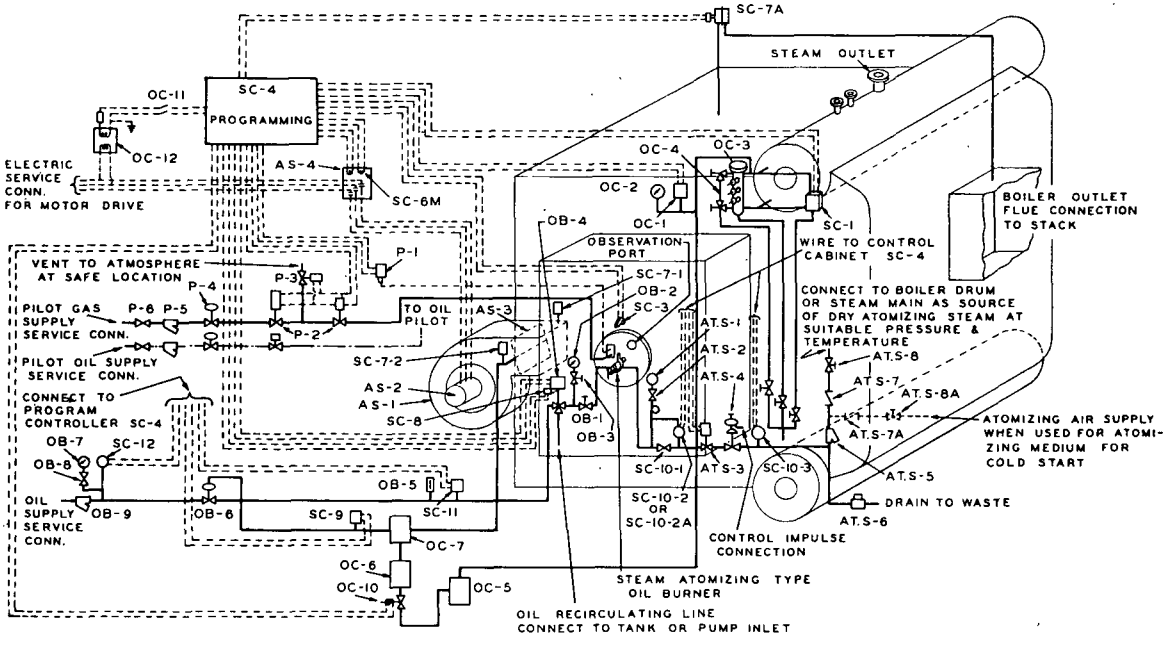
OC-6 Manual auto. selector station (included if OC-5 furnished)

OC-7 Combustion control drive unit or units

OC-11 Manual operating switch

OC-12 Control transformer

OC-13 Pilot manual control station



APPENDIX D

OIL FIRING ONLY

Typical Schematic Arrangement of Safety Equipment
Fuel Oil-Fired Watertube Boiler with One (1) Burner
Automatic (recycling) or Automatic (non-recycling) Controls

Atomizing Steam System:

ATS-1	Burner atomizing steam pressure gage
ATS-2	Burner atomizing steam pressure gage cock
ATS-3	Atomizing steam shut-off valve
ATS-4	Atomizing steam differential pressure control valve
ATS-5	Atomizing steam supply strainer
ATS-6	Atomizing steam supply trap
ATS-7	Atomizing steam supply check valve
ATS-7A	Atomizing air supply check valve
ATS-8	Atomizing steam supply shut-off valve
ATS-8A	Atomizing air supply shut-off valve

Air System:

AS-1	Forced draft fan
AS-2	Forced draft fan motor
AS-3	Forced draft fan control damper at inlet or outlet
AS-4	Forced draft fan motor starter

Pilot System — Gas or Oil:

P-1	Pilot ignition transformer
P-2	Safety shutoff valves — auto. opening, spring closing (NC)
P-3	Vent valve — auto. closing, spring opening (NO)
P-4	Pressure regulating valve — optional depending on pilot pressure requirements.
P-5	Strainer
P-6	Manual plug cock

Oil Burner System:

OB-1	Manual oil shutoff valve
OB-2	Oil burner pressure gage
OB-3	Oil burner pressure gage cock
OB-4	Safety shutoff and recirculating valve
OB-5	Oil temperature thermometer or gage (Note 4)
OB-6	Oil control valve
OB-7	Oil supply pressure gage
OB-8	Oil supply pressure gage cock
OB-9	Oil strainer

Safety Controls: (All switches in "hot" ungrounded lines. See 5652)

SC-1	Low water cut out integral with column or separate from water column
SC-3	Flame scanner
SC-4	Program controller (contains lights,switches,relays,timers,etc.)
SC-6M	Loss of air supply aux. contact in motor starter
SC-7-1	Windbox pressure switch (Note 2)
SC-7-2	Fan damper position switch (Note 2)
SC-7A	Purge airflow switch (Note 2)
SC-8	Closed position interlock on OB-4
SC-9	Light-off position interlock
SC-10-1	Atomizing steam flow interlock orifice
SC-10-2	Atomizing steam flow interlock differential pressure switch
SC-10-2A	Atomizing steam pressure interlock switch
SC-10-3	Atomizing steam supply pressure interlock switch
SC-11	Low oil temperature interlock (Note 4)
SC-12	Low oil supply pressure interlock

Operating Controls & Instruments:

OC-1	High steam pressure switch (Note 1)
OC-2	Steam drum pressure gage
OC-3	Water column with high & low level alarms
OC-4	Water gage and valves
OC-5	Steam pressure controller
OC-6	Manual auto. selector station
OC-7	Combustion control drive unit or units
OC-10	Modulating control low fire start positioner
OC-11	Manual operating switch
OC-12	Control transformer

NOTES:
1. With automatic (non-recycling) control, an overpressure shutdown requires manual restart.
2. Purge airflow may be proved by providing either SC-7-1 and SC-7-2 (and similar devices for other dampers which are in series) or SC-7A.
3. Atomizing steam interlock may be accomplished by providing either SC-10-1 and SC-10-2 or SC-10-2A and SC-10-3.
4. Temperature interlock and thermometer omitted for light oils which do not require heating.
5. Arrangement shown is applicable to straight mechanical pressure atomizing oil burners by omitting atomizing steam system.