STUDY MATERIAL

CERTIFICATE OF FITNESS FOR CONSOLIDATED EXAM FOR:

LOW PRESSURE OIL BOILER

P-99

ALSO INCLUDED IN THIS BOOKLET YOU WILL FIND THE FOLLOWING:

1. NOTICE OF EXAMINATION (NOE)

NOTICE OF EXAMINATION FOR

Title: **Consolidated Examination for the Certificate of Fitness for Complex-wide Low PSI Oil Burner Operator (P-14), Supervise Low PSI Oil Burner Operator (P-16), and Mobile Emergency Low PSI Oil Burner Operator (P-20)**

Date of Test: Written tests are conducted Monday to Friday (except legal holidays) 9:00 AM to 2:30 PM.

QUALIFICATION REQUIREMENTS

1. Applicants must be at least 18 years of age.
2. Applicants must have a reasonable understanding of the English language.
3. Applicants must present a letter of recommendation from his/her employer, trade school or trade union. The letter must be on official letterhead and must state the applicant's full name, character, physical condition, experience, and address of premises where applicant will be employed. Self-employed applicants must submit a notarized letter.
4. Applicants must present two (2) forms of satisfactory picture identification i.e., driver's license and passport ID pictures.

APPLICATION INFORMATION

Application Fees: $25.00 for originals and $5.00 for renewals. The fee may be paid in cash, money order, or personal check payable to New York City Fire Department. The $25.00 fee must be payable by all applicants prior to taking the Certificate of Fitness test. Application forms are available at the Public Certification Unit, 1st floor, 9 MetroTech Center, Brooklyn, NY 11201.

TEST INFORMATION

Test: The test will be of the written, multiple choice type. A passing score of at least 70% is required in order to secure a Certificate of Fitness. Individuals holding a Certificate of Competence as a Boiler Inspector form the NYS Dept. of Labor; or a license as a High Pressure Boiler Operating Engineer or a license as an Oil Burning Equipment Installer from the Dept. of Buildings may have the written test waived. This procedure is the **Alternative Issuance Policy.** Call (718) 999-1993 for additional information and forms.

This Study Material contains some of the information you will need to prepare for the Consolidated examination for the certificate of Fitness for Complex-wide Low PSI Oil Burner Operator (P-14), Supervisor of Low PSI Oil Burner (P-16), and Mobile Emergency Low PSI Oil Burner Operator (P-20). The study material includes information taken, for the most part, from relevant sections of the Building Code of New York. Other information describes the proper operation and maintenance of low PSI oil burner systems.

All questions on the Certificate of Fitness examination are multiple choice, with four alternative answers to each question. Only one answer is correct for each question. If you do not answer a question, or if you mark more than one alternative your answer will be scored as incorrect. A score of 70% correct is required on the examination in order to qualify for the Certificate of Fitness. Read each question carefully before marking your answer. There is no penalty for guessing.

Sample Questions

_____1. A fill line in an oil burner system is a line used to:
(A) fill the boiler with water.
(B) keep the hot water preheater full.
(C) fill the storage tank with oil.
(D) carry water to the gauge glass.

The correct answer is "**C**". You would press "**C**" on your touch-screen monitor.

_____2. The aquastat is located:
(A) below the water line.
(B) on the steam line.
(C) above the water line.
(D) on the low water cut-off.

The correct answer is "**A**". You would mark "**A**" on your touch-screen monitor.

EXTRACTIONS FROM THE BUILDING CODE OF NEW YORK

BUILDING CODE OF NEW YORK SUBCHAPTER 14

HEATING AND COMBUSTION EQUIPMENT

General requirements. All heating, combustion, and cooking equipment shall be installed with adequate clearances from combustible construction. Either the equipment shall be provided with insulation or the building construction shall be fire protected, so that during operation the surface of combustible construction materials will not be raised to a temperature higher than 170° Fahrenheit. Equipment shall be so that the means of access for ordinary operation and maintenance will not be hazardous.

Inspections and tests. (a) **Acceptance tests**. Boilers shall not be placed in operation upon completion of construction until they have been inspected and tested and an equipment use permit has been issued by the commissioner. (b) **Periodic boiler inspections**. All boilers shall be inspected at least once a year including chimney connections. (c) **Owners annual statement**. The owner of each boiler that is subject to periodic inspections shall file an annual written statement with the commissioner, specifying the location of each boiler and arrangement for inspection.

Fuel burning and fuel storage installations. (a) **Field Tests**. (1) All liquid fuel piping and fuel oil storage tanks shall be hydrostatically tested for tightness by the contractor who made the installation before the work is closed in and before the system is operated. The piping shall be tested at one-half times the maximum working pressure applicable to that part of the piping system but at a pressure less than the test pressure required for the storage tank. The minimum pressure for testing tanks shall be one and on-half times the maximum working pressure applicable to the tank but in no case for less than twenty-five psi. The hydrostatic pressure shall be maintained until all joints and connections have been visually inspected for leaks, but in no case for less than one-half hour. A record shall be kept of the pressure test showing the name of the contractor and the pressure at which the piping and the tank were tested. (2) Gas distribution piping shall be tested for tightness by the contractor who made the installation before the work is closed in and before the system is operated. (b) **Instruction Cards**. For oil burning systems, cards giving complete instructions for the care and operation of the system shall be furnished and shall be permanently located in an easily visible and accessible location near the equipment.

Licenses and certificates. No oil burning equipment shall be operated until an equipment use permit has been issued by the commissioner, the requirements of the air pollution control code have been met and until approval for the storage of fuel oil has been given by the fire commissioner. ***Every oil burning installation that is not fully automatic or requires preheating shall be operated by, or under, the direct supervision of a person holding a certificate of fitness issued by the fire commissioner.*** Such person shall be in the building at all times while the burners are in operation, and shall be present in the boiler room during the starting of the operation of a boiler.

Operators inspection after repairs. After any repairs are made to a boiler or fuel burning equipment for which licensed or qualified operators are required, such operators shall check the repairs, together with the functioning of all control devices and the positioning of the valves. These licensed or qualified operators also shall be present during the starting of the operation of the equipment and shall be responsible for the proper and safe operation of such equipment.

Abatement of air contaminants. All heating and combustion equipment that is fired with solid, liquid, or gas fuels including all rubbish burners and incinerators, shall comply with the requirements of the air pollution control code.

Equipment classification. (1) **Low temperature equipment**. Equipment whose products of combustion at the point of leaving the equipment have a temperature of 600° Fahrenheit or less under normal conditions.

(2) **Medium temperature equipment**. Equipment whose products of combustion at the point of leaving the equipment have a temperature between 600° and 1000° Fahrenheit under normal operating conditions. (3) **High temperature equipment**. Equipment whose products of combustion at the point of leaving the equipment have a temperature of 1000° Fahrenheit or greater under normal operating conditions.

Combustion air. Air supply. Ventilation shall be capable of providing at least thirty-six cfm of air for each gallon of oil per hour required to fire the equipment to gross output. If the ventilation for the purpose of combustion is supplied mechanically, the ventilating system shall be electrically interlocked with the burner so that when the burner is in operation, the ventilating system shall maintain the room in which the equipment is located at a pressure no less than the outdoors atmospheric pressure. Flue dampers. Dampers in flues shall be constructed so that they cannot completely cut off the passage of flue gases at any time. Tight closing dampers may be installed with approved automatic draft and combustion controls.

Fuel oil equipment. General requirements. Fuel oil shall mean hydrocarbon oils with a flashpoint not lower than 100° Fahrenheit and marketed under the following commercial grade: range oil or no. 1 fuel oil; diesel oil or no. 2 fuel oil; no. 4 fuel oil; no. 5 fuel oil; no. 6 fuel oil. The use of crankcase refuse oil as fuel oil is prohibited. **Piping.** Installation of piping and tubing. Overflow pipes, where installed, shall not be smaller in size than the supply pipe. Where a shut-off valve is installed in the discharge line from an oil pump, a relief valve shall be installed in the discharge line between the pump and the first shut-off valve. A relief or pressure regulating valve shall be provided in the oil piping system on the heater side of the shut-off valves. **Heating coils in storage tanks.** The heating of oil in storage tanks shall be by means of coils using low pressure hot water or steam, or by means of electric heaters approved for use in oil storage tanks. Where a single tank and a single burner are installed, a shut-off valve shall be required in the supply line at the tank and another at the burner.

A remote control shall be provided to stop the flow of oil to any burner. Such control shall be located outside the entrance to the room in which the burner is located and as close to such entrance as practicable, except that when an outside location is impracticable, such control may be located immediately inside the room in which the burner is located, provided such location is accessible at all times. All such controls shall be permanently labeled “remote control for oil burner.” On storage tanks of sixty gallon or less capacity used with manually operated burners, such remote control may be installed in the supply lines between tank and burner. Pressure in a storage tank for the purpose of discharging oil shall be prohibited.

Controls. With each automatic burner a set of safety controls of electric, pneumatic, hydraulic or mechanical type shall be installed and maintained in good working order. The controls shall provide the following functions: (a) **oil temperature control** (no. 5 and no. 6 oil). (b) **Ignition**. (c) **Stack or combustion control**. (d) **High temperature or pressure control**.

Chimneys. No oil burner shall be installed unless it is connected to a chimney.

OVERVIEW OF LOW PSI OIL BURNER OPERATION AND CONTROLS

Oil Circulation in The System

The following material provides an overview description of the process of oil circulation in the burner system. When reading the following, refer to DIAGRAM 1, the **Oil Circulating Diagram** on the following page.

The oil storage tank provides the supply of oil for combustion in the oil burner. In its normal condition, no. 6 fuel oil is very thick and heavy and is not easily pumped through the circulation system. For this reason the oil in the storage tank is heated. The temperature in the storage tank is usually maintained between 100°and 130° Fahrenheit.

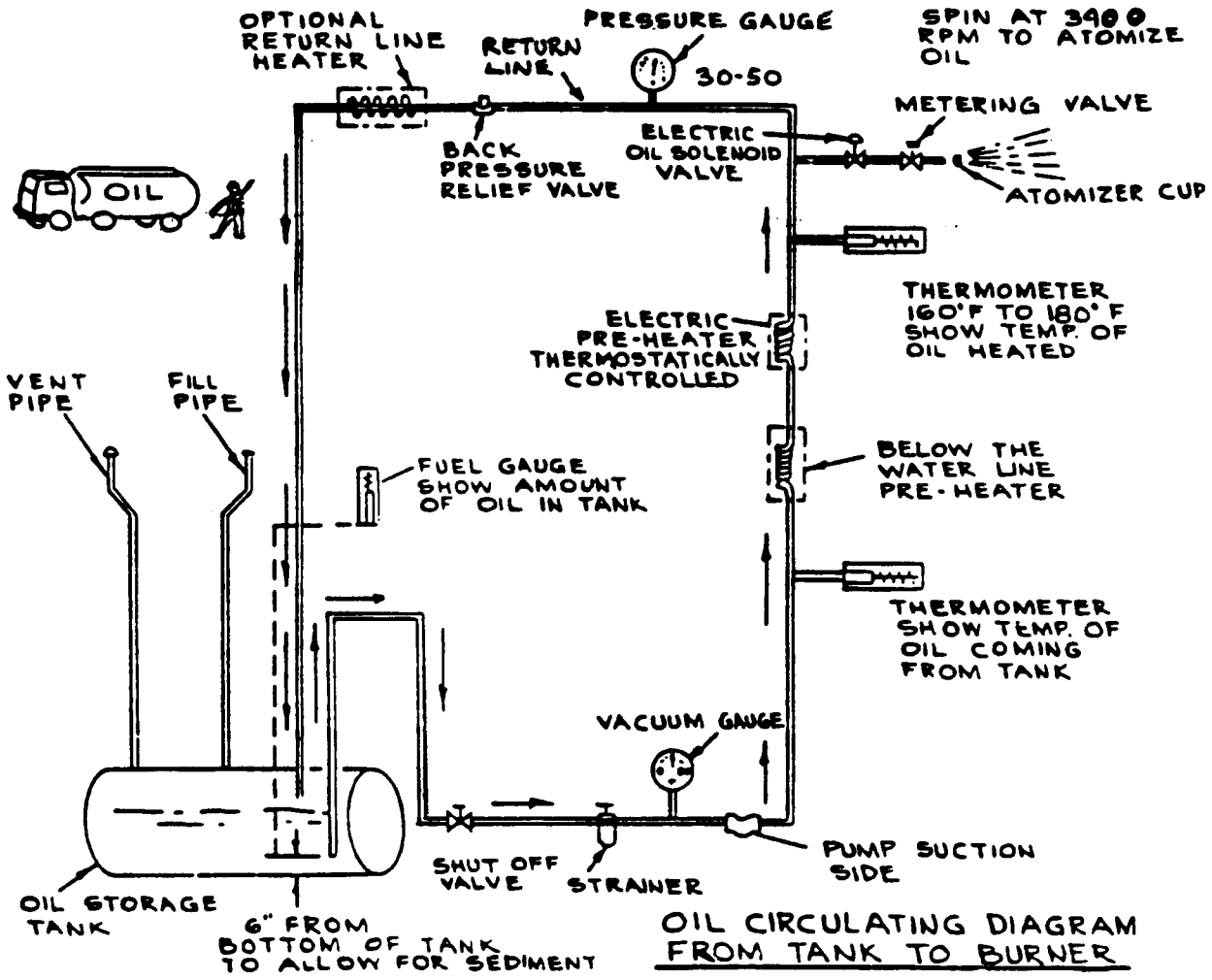
A suction cup circulates the oil throughout the system. Dirt and sediment are present in the fuel oil coming from the oil storage tank. The oil strainer removes most of these contaminants from the oil before the oil reaches the burner. The vacuum gauge is a device that measures pressure below atmospheric pressure. Excessive vacuum readings indicate that there is an obstruction in the suction line (such as dirty oil strainer). When this occurs the flow of oil can be stopped by closing the shut-off valve. This permits the operator to clean the strainer or to perform other maintenance.

Preheaters are used to heat the oil further before the oil enters the burner for combustion. The oil is heated to between 160° and 180° Fahrenheit. Preheating makes it easier to pump the oil and also makes it easier to atomize the oil. The oil is metered into the burner where it is atomized by the spinner or atomizer cup. The atomized oil and air are mixed in the combustion chamber and burned.

The main fuel valve is electrically operated and will open or close the line leading to the atomizer of the oil burner. It will shut down the burner system if there is a failure of ignition or combustion.

Oil circulates through the system back to the storage tank through the oil return line. The normal oil pressure for no. 6 oil burners is between 30 and 50 psi. A back pressure relief valve is provided for safety if the pressure becomes too great. Additional heaters may be present in the return line to ensure that the oil is maintained at the proper temperature for easy circulation in the system.

DIAGRAM 1 – OIL CIRCULATION



OIL BURNER OPERATION

Combustion is the chemical union of the oxygen in the air with combustible elements in the fuel oil (hydrogen and carbon). The end result of this process is the production of heat energy. Oil firing equipment is used to liberate heat energy from the fuel oil. Oil burners are the principal components of the oil firing equipment and provide the means of supporting the process of combustion.

Carbon and hydrogen are the two principal elements of fuel oil. During the combustion process, the carbon content of the fuel oil (about 85%) unites with the oxygen in the air and forms carbon dioxide and carbon monoxide. The hydrogen content of the oil (about 14%) unites with the oxygen and produces water. The objective is to have as complete a combustion process as possible. This objective is met when the fuel oil combines with the greatest possible amount of oxygen.

Oil is a liquid fuel and as such will not burn. It must be changed to a gas or vapor and mixed with air if it is to support combustion. The oil burner is primarily a device for processing the liquid fuel for combustion by accelerating the change from liquid to a vapor that can be mixed with air and burned. This process of breaking down or atomizing the oil is necessary to ensure prompt ignition and rapid combustion. Although there are various types of oil burners, they all vaporize or atomize the oil before it enters the combustion chamber where it is mixed with air in predetermined proportions.

The low pressure oil burner uses a low pressure oil pump and mixes air and oil within the nozzle itself. In low pressure oil burners the oil and air mixture is delivered to the nozzle at a pressure from 1 to 15 psi, depending on the make of the burner. The air that contacts the oil prior to its leaving the nozzle is referred to as primary air. The introduction of air from the blower or fan into the combustion chamber after the oil has left the nozzle is referred to as secondary air. Every brand of low pressure burner is essentially unique and different from that of other manufacturers. Thus it is important that an operator of a low pressure oil burner system understand the functions of his/her particular system completely.

Oil burners require approximately 2000 cubic feet of air per gallon of oil consumed. The mixture of oil and air is sprayed in vapor form into a firebox area (the combustion chamber) where combustion takes place. The mixture of air and fuel in the burner must be strictly controlled. Poor mixture could become an explosive mixture. During the process of combustion, one part of carbon unites with two parts of oxygen to produce carbon dioxide (CO_2). Each time one pound of carbon is burned, 14,544 BTU of heat are liberated. Carbon dioxide is recognized as the end product of complete combustion. Should the fuel be raised to the correct temperature but not supplied with the proper amount of oxygen, carbon monoxide will be produced, and only 4,480 BTU of heat liberated. Carbon monoxide is recognized as the end product of incomplete combustion. In addition to being inefficient in the production of heat, the presence of carbon monoxide is highly dangerous.

If the proper amount of air has been thoroughly mixed with the oil, and the temperature of the flame is correct, the free carbon burns completely. A correctly adjusted oil burner flame will have an orange colored flame body with small red tips. These tips will be slightly cloudy. A red, smoky flame is an indication of a lack or air. A white, almost dazzling flame is an indication of a great amount of excess air. An insufficient air supply is one cause of dense, black smoke and soot; an excessive air supply can blow out the flame.

The oil spray entering the combustion chamber burns in suspension. If any part of the spray mixture that contacts the walls of the combustion chamber it will cause a smoky fire. Over a period of time carbon deposits may build up in the combustion chamber and cause a burner failure.

Insulating firebrick makes up the walls of the combustion chamber. Insulating firebrick is lightweight firebrick that becomes cherry red 15 seconds after the burner starts. The refractory material in the combustion chamber should be closed to the flame and the oil should be burned by the reflected heat. Reflected heat, which increases combustion efficiency, is heat that is reflected back into the combustion chamber and maintains the fire after the ignition is turned off.

Fuel oil comes in several grades, from range oil or no. 1 fuel oil, to diesel oil or no. 2 fuel oil; to the heavier no. 4, no. 5, and no. 6 fuel oils. No. 6 fuel oil (sometimes called "bunker C oil" or residual fuel oil) is the heaviest commercial fuel oil. When cold, it is almost of a solid consistency. It also contains the most sediment. Strainers are required in the oil line to filter out dirt and sediment. The oil in the storage tank is maintained in a preheated condition so that when it is required it can be moved through the piping to the oil burning unit. The storage temperature range is usually just a little above the 100° Fahrenheit mark. When using heavy oil such as no. 6 oil, combustion is improved if the temperature of the oil is further increased before atomization and combustion. The fuel temperature is raised to about 180° Fahrenheit before it enters the combustion process.

Several conditions can lead to improper operation of the oil burner system and to possibly dangerous situations.

1. A defective oil cut-off valve can lead to after-drip. This is a very common condition. The oil drips into the combustion chamber when the burner is off, and the excessive oil is absorbed by the combustion chamber floor and walls. This cause the burner to be unusually noisy when it starts up or shuts down. It will eventually lead to a carbon deposit build-up and to a less efficient operation of the burner. After-drip is also dangerous in that it may lead to fire on the floor in front of the heating unit.
2. A leaking seal on the oil pump shaft bearing may also cause oil to leak on the floor in front of the heating unit. The leaked oil could become ignited also.
3. Dirty or damaged nozzles or rotary cups can cause improper atomization. This will eventually lead to a carbon deposit build-up in the combustion chamber. Nozzles in the no. 6 oil burner should be cleaned at least once a day.
4. Blockage in the chimney or flue passage will cause the cellar or boiler room to become filled with smoke.
5. Water in the fuel oil or the wrong grade of fuel oil will cause improper atomization.
6. The protective relay is supported to shut down the oil burner if a flame is not established quickly. A delay in ignition is the most common cause for burner puff-back. Puff-back can cause the boiler door to blow open and the smoke pipe to fall down.

One of the most dangerous conditions that occurs is when the oil burner goes into operation when the chamber is not hot and the source of ignition fails. If the chamber has not been preheated, the combustion chamber, the flue, and the chimney can become filled with vaporized oil fumes. These fumes may become ignited and cause a puff-back. If proper ignition has not occurred the only indication of flame failure may be a strong odor of fuel oil in the area. Vaporized oil looks like condensed steam; it is pure white but smells and tastes like fuel oil. When this condition is present it should be handled by immediately shutting off the burner. The area should be completely vented. Any possible source of ignition should be eliminated. An attempt should not be made to light the burner until the system has been completely cleared of combustible mixtures. Preventive maintenance should be done regularly to maintain reliability of the equipment and control devices. Regular preventive maintenance also reduces the need for corrective maintenance. Cleanliness and good housekeeping practices will also contribute to the prevention of fire and explosion.

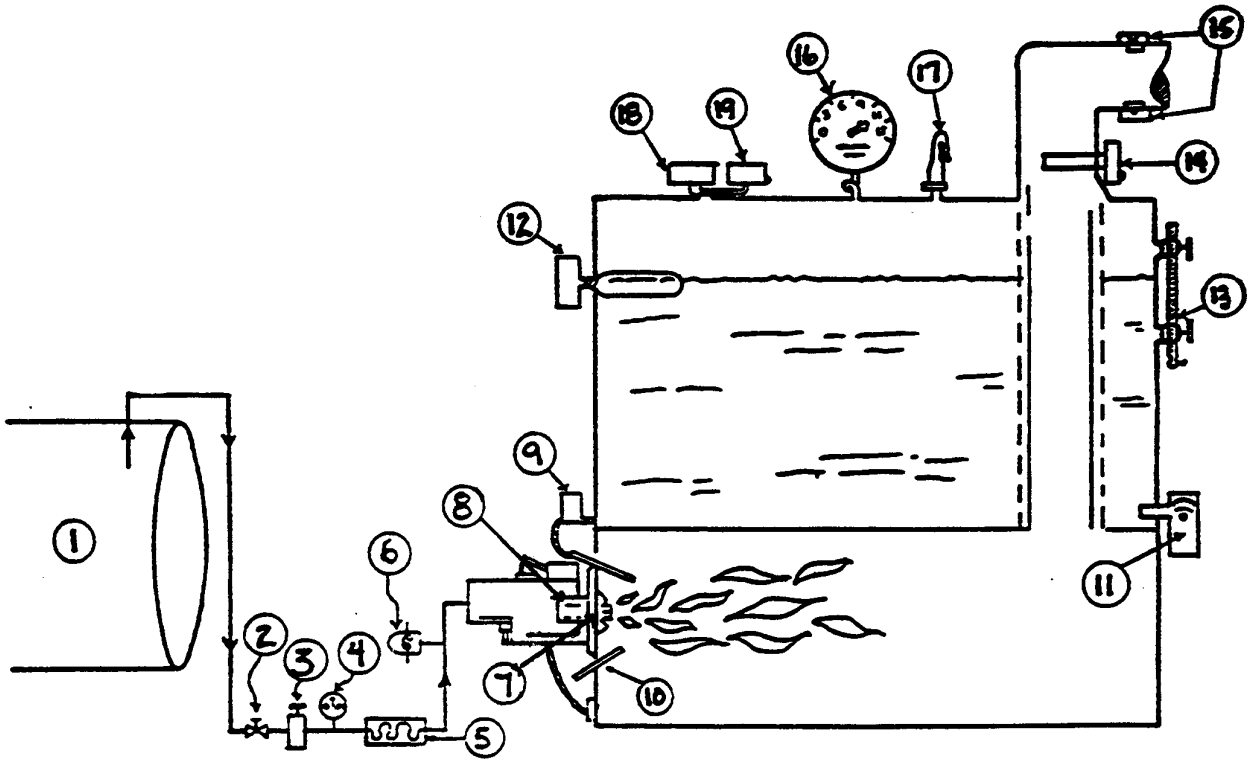
OIL BURNER CONTROLS

The following information describes in more detail the various controls and devices on the oil burner and boiler. When reading the following refer to the DIAGRAM 2, **Oil Burner Controls**.

1. As described earlier, the fuel oil is stored in the oil storage tank.
2. The tank shut-off valve permits the operator to stop the flow of oil to clean the strainer and to perform other maintenance.
3. The oil strainer separates dirt and sediment from the fuel oil coming from the storage tank.
4. The vacuum gauge readings indicate to the operator whether there is an obstruction in the suction line (e.g., the oil strainer is dirty and requires cleaning).
5. The oil preheater raises the temperature of the oil for easier pumping and atomization.
6. The main fuel valve is an electrically operated valve that will open or close the line leading to the atomizer of the oil burner. Under certain conditions it is activated by the primary control (#14). The burner shut-off valve is located as close as possible to the burner to reduce the amount of oil remaining in the burner line after an emergency shut down.
7. The atomizing cup (spinner) is a device that breaks up (atomizes) the fuel oil for proper combustion.
8. The vaporstat is a low pressure; pressure control mounted on the fan housing and will shut down an oil burner if no air for combustion exists. A dangerous condition occurs when the oil is being pumped to the combustion chamber and is not being atomized properly. An explosion may result.
9. The mixture of fuel oil and air is ignited at first by a gas pilot or by electric ignition. After ignition, combustion is maintained by retained heat in the combustion chamber.
10. The photoelectric cell is a flame detection control. It is a device that will shut down an oil burner if a flame is not visible to the scanner or photoelectric cell. A dangerous condition will arise if oil is being pumped into the combustion chamber, but not burning. The atomized, unburned fuel could cause an explosion if a spark or other source of ignition occurred.
11. The aquastat operates the oil burner in the summer for domestic hot water needs.
12. The low water cut-off is an automatic electric control that will shut the burner when the water level is below a safe operating point. A shortage of water in the steam boiler could lead to a dangerous condition.
13. The gauge glass is a device used to indicate the water level of a steam boiler. It is the most important control on the steam boiler. The gauge glass should have water visible when the boiler is in operation.
14. The stack switch (or primary control) is the main combustion controller. It will stop the oil burner and lock it out on safety in case of ignition failure or loss of flame in the combustion chamber. The stack switch operates when there is no heat in the smoke stack. A dangerous condition arises if the oil is being atomized and vaporized in the combustion chamber but no flame exists. A spark could cause an explosion in the combustion chamber.
15. The smoke alarm is a device mounted on the smoke stack or chimney. The smoke alarm will shut down an oil burner and put on an alarm if there is excessive smoke or if the fire is improper. A dangerous condition would exist if all the oil were not being burned or properly atomized, or too much oil was admitted to the combustion chamber. If the condition is not corrected, an explosion may occur. The smoke alarm is also a required combustion and air pollution control.
16. The boiler steam pressure gauge shows the steam pressure inside the steam boiler. The pressure gauge reads in psi (pounds per square inch). It is located on or near the top of the steam boiler. Normal steam pressure for low pressure boilers is less than 15 psi.
17. The safety or pop off valve is a device used to relieve excessive steam pressure. It is located on or near the top of a steam boiler.

18. The pressuretrol (Pressure Control) is an automatic electric control. It is an operating limit control and is a device that will shut down the oil burner when the steam pressure reaches a desired point. A dangerous condition could occur when the steam pressure is rising. If the pressure continued to rise unchecked, the boiler could blow up.
19. The manual reset pressuretrol is a control that will shut down a steam boiler if the pressure continues to rise above the operating pressure control setting. It will lock out the oil burner on safety in case the operating limit pressuretrol (#18) fails to stop the oil burner. This switch will not close again automatically. It must be rest manually.

DIAGRAM 2 – OIL BURNER CONTROLS



1 - Storage tank
2 - Tank shut off valve
3 - Oil strainer
4 - Vacuum gauge
5 - Oil preheater
6 - Main fuel valve
7 - Atomizing cup
8 - Vaporstat
9 - Ignition
10 - Photoelectric cell
11 - Aquastat
12 - Low water cut off
13 - Gauge glass
14 - Stack switch
15 - Smoke alarm
16 - Boiler pressure gauge
17 - Safety valve
18 - Pressuretrol
19 - Pressuretrol (manual)