THE PENNSYLVANIA RAILROAD

Locomotive Maintenance Instructions No. L-45

ISSUED PHILADELPHIA, PA.
APRIL 11, 1938

Servicing, Handling, Operation, Inspection and Maintenance of Oil Fired Steam Locomotives, Their Tenders, and of Storage Tanks in Enginehouses.

1. Storage Tanks: (a) Oil storage tanks shall be maintained free from leaks. Each tank must be provided with an air vent 1" in diameter at the highest part, and a manhole with netting or screen under the same.

(b) Keep flames and sparks away from air vent and open manholes, using incandescent lamps or flash lights only. The same safety precaution must be taken when entering storage tanks as required by paragraph 17 for Fuel Oil Tanks.

(c) As a precaution against fire, a supply of sand should be kept in container close to where the oil-fired locomotives are serviced and repaired. Containers should be stenciled "SAND FOR OIL FIRES ONLY".

(d) Manhole opening must be tightly closed after filling tank. Oil level in tank must never be less than 2" from top sheet, to provide for expansion.

2. Equipment on Tender: (a) Oil storage tank located on tender is equipped with a main oil heater near bottom of the tank, the shell of which terminates in a header casting, and also forms the body of the safety oil valve.

(b) The safety oil valve is operated by a long rod, or stem, extending through the top sheet of the supply tank. The valve is held open against a spring by means of a pin, or cotter key, through a hole in the top of the valve rod, the pin, or cotter key, being attached to the cab of the locomotive by a cable or chain. If a locomotive becomes separated from its tender, the pin or cotter key will be pulled out, releasing the spring, which in turn closes the safety oil valve.

(c) A long emergency set screw is provided, in the vertical oil pipe below the storage tank, leading out of the safety oil valve body, to hold the safety oil valve open in case the long valve rod is broken. When necessary to use the set screw, it must be screwed up-ward as far as it will go. Under normal conditions the set screw must be left screwed down-ward as far as it will go. All cases where set screw has been used must be reported at the end of the run, and the locomotive must not be returned to service until the safety oil valve is repaired. Access to the emergency set screw is through the trap door in the deck plate in front of the oil supply tank.

(d) A main cut-out cock is provided in the oil pipe leading from the bottom of the storage tank. This cock is operated from the ground by means of a lever with extension rod, terminating in a handle on the left front side of the tender. In case of emergency, the flow of oil through the feed pipe to the locomotive can be shut off from the ground by pulling the handle out as far as it will come. When the oil burner is in operation this handle must be pushed in as far as it will go. Both the safety oil valve and the main cut-out cock must be kept closed when the oil burner is not in use.

(e) The steam supply to the main oil heater in the storage tank is controlled by a valve in the locomotive cab. The hand wheel on the globe valve in the exhaust line is located above the tender deck to the left of the center line. This valve must be open wide when oil burner is not operated, but must be adjusted to permit the condensed water to run out without blowing steam to the atmosphere when oil burner is being used.

(f) The oil agitating and direct heating steam line extends back over the top sheet of the oil tank and down into the tank terminating in nozzles close to the screen at entrance of main oil heater. The control valve is located in the vertical pipe at the front of the tank. The steam in this line may be used when it is necessary to quickly heat the oil around the screen at entrance to main oil heater, and then it must be used only long enough to start the oil flowing to the locomotive. This steam line must not be used to heat the oil around the main oil heater screen when the steam to the main heater can be turned on long enough to sufficiently heat the oil before it is desired to light the oil burner. The steam in this line is primarily intended to agitate the oil around the entrance to the main heater in order to keep the free carbon and sediment in suspension in the oil and thus prevent the heating surfaces of the main heater from being heavily coated with carbon. At least once every hour, while the locomotive is in service, the steam must be turned into this line for a period not over 30 seconds to agitate the oil.

(g) A ¾" drain pipe with globe valve is connected to the bottom of the oil storage tank.

3. **Equipment on Locomotive:** (a) The draft pan and combustion chamber in the firebox are lined with fire brick on the floor and up the sides and ends to the lower edge of the fire door. The combustion chamber is air tight, except adjustable draft openings in the front end and in the floor of the draft pan. These openings are regulated by dampers, operated from handles in the cab. The dampers are closed when the handles are pulled up as far as they will go.

(b) In applying or repairing fire brick, ground fire clay and water, thoroughly mixed to a consistency of thin paste, or mortar, must be used. The brick must be placed as close together as possible, and corners and small cavities filled with pieces of broken brick laid in the fire clay mortar. Large quantities of fire clay mortar must not be used at one point. After the brick setting has been completed, all exposed surfaces must be coated with a solution of soda ash and water, mixed until it will flow freely. The coating should be thin, and, when heated, forms a fire resisting surface over the bricks. Under no circumstances shall brick work be cooled by pouring water over the surface.

(c) The fire door is bolted on, and must be kept so when starting fire and while the oil is burning. A double peep hole is provided in the center of the door through which the condition of the fire can be observed, and through which scavenging sand can be fed into the firebox.

(d) The double nozzle oil burner must be adjusted level and parallel with the center line of the boiler so that the oil and steam jet is equidistant from each side wall of the combustion chamber.

(e) The auxiliary oil heater consists of a steam jacket around the 2" oil pipe with ¾" steam supply pipe (controlled by globe valve in cab) entering the rear end, and ⅜" exhaust drain pipe at front end of heater. The ⅜" exhaust drain is equipped with a globe valve, which must be adjusted to keep the oil at the proper burning temperature without blowing steam to atmosphere.

(f) A 1½" main steam supply line with 1½" check valve is taken from the top of the bridge pipe turret, and is then divided into 1" and 1¼" pipes. The 1" pipe divides into three ¾" pipes, each with globe valve, one leading to the main heater on tender, the second into the oil feed pipe back of the auxiliary heater, and the third into the rear end of the auxiliary heater. The 1¼" pipe line passes through a standard 1¼" blower valve and then divides into ¾" and 1¼" pipes. The ¾" line, equipped with globe valve in cab, leads to the burner, the 1¼" line leads to the blower connection at the left side of the smoke box.

(g) The 2" oil feed pipe passes through the auxiliary heater to the oil control valve at the front of the draft pan, then reduces to 1¼" pipe size and enters the burner.

(h) Oil feed control is connected through a vertical shaft passing through the deck plate near the left corner of the back head.

4. **Starting Fire:** (a) It is necessary to have steam for heating and atomizing the oil. This steam is usually secured from the roundhouse blower lines or from another locomotive, and should be connected to blower line of the locomotive to be fired up. Where a locomotive has 25 or more pounds of steam, the appliances can be operated entirely with steam from the boiler. All valves in the live steam lines and oil line, on both the locomotive and tender should be closed, and exhaust valves opened before connecting steam supply. When the locomotive has sufficient steam pressure, the outside source of supply may be shut off by closing globe valve in supply line just inside of cab, without closing the regular locomotive blower valve, or extinguishing the fire. Where outside steam supply is not available, wood may be used until 25 lbs. of steam is generated, care being taken not to damage brick work or burner. All the wood should be consumed before locomotive leaves terminal.

(b) The interior of the firebox should be examined to see that all parts are clean and in serviceable condition. Turn on steam to main heater, closing the valve in the heater exhaust until it drips condensate at the rate found necessary to properly heat the oil. In cold weather it will be necessary to heat the oil in the line between the engine and tender. Open the main cut-out cock, and the safety oil valve. Open the blow back steam valve. Then close the main cut-out cock, and open the firing valve. Close firing valve and blow back steam valve. Turn on blower and open both dampers to draw any gas that may be in the smokebox out the stack. Try the atomizer opening in the burner. The steam jet should flow from the burner nozzle in a fan like spray, uniform and equally distant from the brick side walls. Be sure that nozzle opening is clean before starting fire.

(c) Immediately before lighting the fire, see that no one is under the locomotive near the firebox.

(d) When about to light the fire, increase the blower draft, if necessary, and blow the water out of the pipes and burner by the use of the atomizer steam valve. Throw burning waste or a lighted fusee to within 2 feet of the front of the burner.

(e) Close and fasten fire door and sanding hole door. Never unfasten fire door while oil is turned on the burner; observe firebox conditions through the peep hole until oil is ignited. After fire is established observations may be made through the sanding door opening.

(f) Turn on atomizer steam and then open the oil control valve until ignition of the oil takes place.

(g) After the fire is burning steadily, the atomizer and oil control valve should be opened wide enough to carry the flame back to the flash wall. When the fire is started, and the brick work is cold, only a light fire should be maintained. See that all of the oil passing through the burner is being consumed in the firebox. A fire having a bright color denotes proper burning of oil, while a dull red, smoky flame indicates the oil is not being consumed and is resulting in black smoke as well as soot accumulation in the firebox and tubes.

(h) It is important to see that fire does not go out when firing up, or when locomotive is standing. White or milk colored smoke at the stack is an indication that the fire has gone out and the oil is flowing on the hot brick work in the fire pan. This white colored smoke is a highly explosive gas, and before relighting the fire, the oil should be shut off and the firebox cleared of gases. The practice of relighting fire from the heated brick work, even if fire has been out for a very short time, **is very dangerous and is strictly forbidden.**

5. **Handling Locomotives at Terminals:** (a) Locomotives left standing under steam should have the fires turned out and all dampers closed, except when the hostler or watchman can be present to fire the locomotive sufficiently to keep steam pressure and water in the boiler.

(b) An oil burning locomotive in which a low fire is burning, should not be moved under its own steam without first increasing the flow of oil to the burner by the amount necessary to prevent the strong draft created by the exhaust from extinguishing the fire. The throttle should not be opened until the flow of oil to the burner is sufficiently increased to prevent strong draft extinguishing the fire. Open throttle carefully to avoid slipping the drivers and creating sudden strong draft.

(c) A good strong fire should be maintained while working the injector on a locomotive standing under steam, and under no circumstances should an injector be opened when the fire is out.

(d) When extinguishing the fire for the purpose of killing the locomotive, or preparatory to leaving it stand for some time without the attention of a hostler or watchman, the safety oil valve in the oil storage tank, should be closed first, and the oil control valve on the locomotive left open long enough to allow the oil in the pipe line to be burned. After all of this oil has been consumed, the oil control valve, main cut-out cock on tender, and all dampers should be closed. It is important that these precautions be observed when placing locomotives in the enginehouse as the oil control valve may accidently be opened by workmen in the cab, and if the other valves have not been closed, oil will escape through the burner, thus creating a fire hazard and a waste of oil.

6. **Duties Before Departure:** Fireman should observe the condition of draft pan, brick work, burner, dampers and pipe connections between locomotive and tender. He should try the emergency oil valve, see that the burner is properly delivering fuel to the fire and that the heater is working properly, also that proper supply of fuel oil, sand and water have been provided as well as the necessary tools for handling an oil fire.

7. **Firing:** (a) The firing of an oil burning locomotive requires close attention at all times to produce economical results. The fireman should be at the control lever in the cab when the locomotive is started. He should increase his fire immediately before the throttle is actually opened, and should reduce it immediately after the throttle is closed. Any change in the position of the throttle or reverse lever while running, should be correspondingly anticipated by the fireman, and the fire regulated accordingly. When switching, or on the road, the fire should at all times be regulated to suit the work the locomotive is performing. When the driving wheels slip the oil control valve should be opened sufficiently to guard against the fire being extinguished by the excessive draft.

(b) The engineer should call the fireman's attention when about to change the position of the throttle or reverse lever.

(c) A white incandescent color at the peep hole in the fire door, and a slightly greyish haze at the stack are most desirable. Black smoke indicates incomplete combustion, and waste of fuel. An absolutely clear stack indicates an excess of air in the gases of combustion, which results in greater firebox heat losses.

(d) The oil control valve, and not the injector or feed water pump should be used to control the steam pressure. The operation of the injector or water pump should be as nearly continuous as possible while the locomotive is working. Variation in the stream requirements of the boiler should be met by change in the adjustment of the injector water valve or water pump throttle as required to maintain a proper water level in the boiler. If, when the locomotive is working, the steam pressure approaches the popping point, and the injector is shut off, the injector should be started only if the boiler needs water. If no water is needed the fire should be reduced. If the injector is started, the oil control valve should be opened slightly, if necessary to maintain working pressure. In no case should the fire be reduced and the injector started at the same time in order to prevent popping.

(e) The use of the injector when standing or drifting should be avoided as far as possible. When it is necessary to use the injector under these circumstances it should be used intermittently and a good fire should be maintained as long as the injector is in use.

(f) When oil burning locomotives are standing or drifting, the dampers should be closed and a light fire maintained to keep the firebox at a uniform temperature, to avoid damaging sheets and tubes. Rapid changes in temperatures of boilers cause expansion and contraction which will develop leaks. To this end, enginemen and firemen should cooperate to prevent cold air being drawn into the firebox.

8. **Use of Blowers:** The purpose of the blower is to create draft when the cylinder exhaust does not create sufficient draft. When the cylinder exhaust creates an equal or greater draft than the blower, the blower valve should be closed as far as it will go until the cylinder exhaust does not create sufficient draft, at which time it should again be opened wide.

9. **Use of Atomizer:** (a) The amount of atomizer necessary varies with the temperature as well as the characteristics of the oil. Best results are secured on oil-burning locomotives by working as little atomizer as is possible to produce complete combustion. An atomizer jet of excessive force will damage the flash wall by cutting away the bricks and will produce a rapid succession of explosions commonly known as "Drumming". Too strong an atomizer is frequently responsible for carbon deposit on the brick work. If the atomizer jet is too weak, it will cause smoke and imperfect combustion. Proper adjustment of the atomizer lies between these two extremes.

(b) When an oil-burning locomotive is standing or drifting with a low fire, the use of too much atomizer will create a succession of light explosions causing puffs of smoke at the peep hole, and a disagreeable gas in the cab. Under the same conditions incomplete combustion results when using too little atomizer because the oil is not carried far enough into the firebox and waste results in oil dripping from the mouth of the burner into the firepan. If the fire kicks or smokes it is an indication that the atomizer should be readjusted. If this fails to stop the trouble, the damper adjustment should be changed to make sure that the admission of excessive air into the firebox is not responsible for the trouble. If the admission of excessive air is not the cause, the temperature of the oil should be investigated to determine whether or not cold oil with irregular feeding is responsible for the condition. Another possible reason for this trouble is irregular fuel supply, due to presence of water in the oil, caused by leakage of the ¾" globe valve in blow back steam line.

(c) When the throttle is closed and the oil control valve has been cut down it is necessary to reduce the steam at the atomizer a corresponding amount. A slight change in the adjustment of the atomizer while the locomotive is working sometimes produces good results, even though the locomotive seems to be steaming well.

10. **Sanding of Flues:** (a) Flues shall be cleaned of soot by floating sand in the opening provided in the fire door, while the locomotive is working hard, until evidence is shown at the stack that the flues are thoroughly cleaned. It is better to use sand frequently and a small quantity at a time, than to use large amounts only a few times on the trip. Flues should be cleaned of soot as soon as possible after the locomotive leaves a terminal, or on leaving a siding where it has been standing for any length of time. When approaching final terminal, flues should be sanded so as to leave them clean when locomotive enters the enginehouse. This saves fuel in preparing the locomotive for the next trip, also cleans the firebox and flues so that the boiler work can be done without delay. Avoid cleaning flues while passing stations or other places where sand and soot discharged from the stack would be objectionable.

(b) Sand delivered to oil burning locomotives for cleaning flues should be thoroughly cleaned, dried and free of pebbles.

11. **Use of Oil Heaters:** (a) Fuel oil should be heated to approximately 150 degrees F. so that it will flow freely at all times. If too high a temperature is maintained it will interfere with the steady flow of oil to the burner, and is also liable to cause the oil to boil and pour out of the vent pipe over the top of the tank.

(b) The direct heater shall be used to heat the oil quickly. After the oil is heated to the proper temperature, the direct heater should be used only for about 30 seconds at a time, to agitate the oil. This should be done at least once each hour while the locomotive is on the road; otherwise free carbon will settle to the bottom of the tank, bake on the heater coils and clog the oil feed lines.

(c) The main oil heater in the tank should be turned on in advance of firing up to insure a steady flow to the burner by the time the fire is lighted. The auxiliary oil heater should not be used as its use results in overheating the oil.

(d) When oil burning locomotives or their tenders are held out of service during freezing weather the oil tank heater should be drained and the water thoroughly blown out with air to prevent damage to the coils from freezing.

(e) Heaters should be watched closely to detect leaks. Oil discharged with the exhaust steam from the heater or execssive accumulation of water in the oil tank, are evidences of leaks. Leaks should be reported and the necessary repairs made.

12. **Admission of Air:** (a) The admission of too much air in the firebox is usually accompanied by a pulsating flame and in most locomotives it is necessary to regulate the air supply by adjusting the dampers until the pulsation is stopped. While drifting, the locomotive should have as little air opening through the fire pan as is possible to use and get good combustion.

(b) To obtain complete combustion, air may be admitted over the fire through the sanding hole in the fire door if necessary.

13. **Black Smoke:** Black smoke must be avoided. This is evidence of imperfect combustion, and in most cases is due to conditions which the fireman can control by proper handling of the oil control lever, heater and dampers. If it is found impossible to make a locomotive steam without smoke, the cause of the trouble should be ascertained and reported on arrival at the terminal. Improper combustion will result in the heating surfaces of the boiler being covered with soot which may cause an oil burning locomotive to fail for steam.

14. **Effect of Water in Fuel Oil:** Excessive amount of water in fuel oil will cause the flame to burn with intermittent flashes or kicking, and at times the fire will die down entirely and then flash up as the water disappears, and the oil reaches the burner. This is a dangerous condition, which will result in steam pressure dropping very rapidly, and may cause the flues to leak. When water in the fuel is in evidence, the ¾" globe valve on blow back steam line should be examined carefully for leakage, and the tank should be drained until all evidence of water has disappeared.

15. **Inspection and Maintenance:** An oil burning locomotive arriving at a terminal should have all parts of the oil burning equipment and brick work carefully inspected, and repairs made promptly. Excessive deposits of carbon must be removed and cause ascertained.

16. **Filling Fuel Oil Tanks:** Care should be exercised when filling tanks to avoid spilling oil on top of tank where it will cause a slipping hazard. Manhole cover must be kept tightly closed.

17. **Entering Fuel Oil Tanks:** Before fuel oil tanks are entered by workmen the tank **must** be steamed out thoroughly and then washed out with cold water to insure the removal of any gas that may have accumulated. Employes are positively prohibited from entering fuel oil tanks which have contained fuel oil until the above instructions have been complied with, and they shall keep lanterns, torches, or any other open lights out of the fuel oil tanks. When necessary to have artificial light in an oil tank incandescent lamps or flash lights only may be used, care being taken not to turn either on or off within 10 feet of tank opening due to danger of sparks being created.

18 Booth Burners: (a) Burners shall conform in all dimensions to tracing D-407236. The oil port and the atomizer slot should be in proper relation horizontally to each other, so that an even distribution of oil will result. Low corners are to be considered as defective.

(b) Atomizer steam slot should extend $\frac{1}{8}$" beyond each side of the oil port opening, and should have a smooth orifice measuring exactly $\frac{1}{32}$".

(c) An oil burning locomotive under-going general repairs should have the burners removed, cleaned repaired and inspected. Defective burners should be sent to Altoona Works for repairs.

(d) Burners to be repaired should be thoroughly cleaned in a lye vat. The atomizer lips should be built up and dressed to tracing dimensions. Burners should be placed on a steam line in a horizontal position and condition of atomizer steam jet noted. The jet should spread equally up and down from the horizontal plane through the burner. If the spread is either up or down in an unequal proportion the burner should be rejected and reworked. Any burner shall be rejected if steam leaks into the oil cavity while under test. The atomizer slot of each burner shall be gauged with taper gauge to insure correct size of opening which is $\frac{1}{32}$".

(e) The burners should be applied so that the atomizer jet will be parallel to the floor of the fire pan and approximately central between the sides of the pan.

F. W. HANKINS,
Assistant Vice-President—
Chief of Motive Power.

THE PENNSYLVANIA RAILROAD
****

Revision of Paragraph 4(d).

LOCOMOTIVE MAINTENANCE INSTRUCTIONS NO. L-45

Servicing, Handling, Operation, Inspection and Maintenance of Oil Fired Steam Locomotives, Their Tenders, and of Storage Tanks in Enginehouses.

****

Philadelphia, Pa.
January 10, 1947.

****

Paragraph 4(d) is hereby changed to read as follows:

4(d) When about to light the fire, increase the blower draft, if necessary, and blow the water out of the pipes and burner by the use of the atomizer steam valve. Throw burning waste to within 2 feet of the front of the burner; a lighted fusee must not be used.

H. T. COVER
Chief of Motive Power.