THE PENNSYLVANIA RAILROAD

DIESEL-ELECTRIC LOCOMOTIVE EXAMINATIONS

FOR

EMPLOYES IN LOCOMOTIVE SERVICE

NO. 12-B
THE PENNSYLVANIA RAILROAD
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FOR EMPLOYES IN LOCOMOTIVE SERVICE
Issued November 1, 1958

GENERAL NOTICE
The examinations contained herein have been compiled with the view to establishing a uniform method of examination and rating for employees in diesel-electric locomotive service who will be required to pass the examination and obtain not less than the minimum rating.

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GENERAL DESCRIPTION

1. Employes when first employed in locomotive service will be furnished with a copy of the authorized progressive examinations on diesel-electric locomotives. They must avail themselves of the facilities, where provided, in order to receive instructions and must continue to study the subjects as outlined in the examinations to become well informed and must pass the required examinations as herein set forth.

2. These examinations are on the progressive plan: First, Second, and Third Progressive Examinations, and the Fourth, or Promotion, Examination.

3. Employes will receive the first Progressive Examination at the end of twelve (12) months extended to cover 365-day period of actual service. The second examination at the end of an additional twelve (12) months, extended to cover 365-day period of actual service, and the third examination after a succeeding period of twelve (12) months, extended to cover 365-day period of actual service. If furloughed, the number of days furloughed will be added to the 365-day period. Ninety (90) days continuous service must be had preceding the several examinations.

4. Employes in locomotive service at the time these examinations become effective, and not having been previously promoted, will be required to pass the First, Second, and Third Progressive Examinations.

5. If an employe is to be promoted to Engineman at the time he receives the Third Progressive Examination, he will be required to take the Fourth, or Promotion Examination; otherwise, he will not be required to take the Promotion Examination until notified by the Road Foreman of Engines to prepare for promotion.

6. An Engineman previously qualified as an Engineman on diesel-electric locomotives will not be required to re-qualify unless he did not fill a diesel-electric locomotive assignment for a period of two years or more.

7. An employe who has been qualified as an Engineman but who has not been used as an Engineman for a
period of two (2) years, will be required to pass the Fourth, or Promotion, Examination before permanently resuming duty as an Engineman.

8. The required rating for the examinations will be as follows:

- First Progressive Examination 80%
- Second Progressive Examination 80%
- Third Progressive Examination 80%
- Fourth or Promotion Examination 85%

9. Employes failing to pass the first examination or any of the several progressive examinations will be allowed thirty days in which to prepare for a re-examination, and failing to pass the re-examination will be allowed an additional thirty days further to prepare themselves for a second re-examination. Employes failing to obtain the required rating after a second re-examination of the several progressive examinations will not be permitted to resume duty until they pass. This opportunity is not to extend beyond nine (9) months and will be canceled if the employe takes employment elsewhere. Reasonable transportation will be given the employe to avail himself of the facilities provided to gain instructions.

Failure to pass the Promotion Examination will be handled in accordance with Promotion Rule.

10. The Examiner may require answers to questions other than those listed in order to determine if a man thoroughly understands the entire subject on which he is being examined. The Examiner may take the employe to a locomotive and have him demonstrate that he fully understands the questions and answers. The employe has the same privilege if he desires to avail himself of it.

11. When the introduction of new equipment requires, employes in locomotive service will be instructed on its use and examined if deemed necessary.

12. All examinations will be oral and Promotion Examination will be individual.
METHOD OF RATING

1. In order that an accurate record may be obtained showing the employe's general knowledge of the locomotives, suitable blanks will be provided, a facsimile of which is shown on the page following the questions.

2. When an employe is being examined, the Examiner will place an (X) mark over the number of the question on which the employe fails, which will represent a total failure on that particular question, while a partial failure will be represented by a diagonal line drawn through the number.

3. For rating purposes, questions have been grouped in blocks of ten (10). Each of the ten questions in a block has a value of ten for a full failure, a value of five for a partial failure. In case of failure to answer a sufficient number of questions to obtain the required rating for a block, another examination will be required of the entire block.

4. After the examination has been completed, and the rating of each block of ten questions is as high as required, the average rating will be obtained by adding the total ratings together and dividing by the number of blocks on which the employe was examined. The average rating will not, however, be considered as a passing mark, unless the specified minimum has been obtained on each of the several blocks.

5. Immediately after the employe is examined, the rating blank should be filled out and forwarded to the Road Foreman of Engines.
FIRST YEAR

101. Q. What is of the first importance in the discharge of your duties on diesel-electric locomotives?
   A. Work safely.

102. Q. What is the general consist of a diesel-electric locomotive?
   A. A locomotive consists of one unit, or two or more units operating in multiple. When operating in multiple, the several units are under control from one operating cab. Locomotive units with operating cabs are designated as “A” units; those without operating cabs as “B” units. A control station is provided on “B” units from which the unit may be operated independently for hostling.

103. Q. How are trucks, axles, traction motors, and engines numbered on a diesel-electric locomotive unit?
   A. The trucks, axles, traction motors, and diesel engines on a unit are numbered consecutively beginning with No. 1 at the “Front” end. The “Front” end of a unit is designated by the letter “F” painted on each side. The “Right” and “Left” sides of a unit are designated by the right and left hands when in the unit facing toward the front end.

104. Q. To identify locomotives properly the P.R.R. uses letters and numbers to classify diesel locomotives; for example, EF-15a. What does the first letter designate?
   A. The first letter designates builder.

105. Q. Name the various builders of diesel locomotives the P.R.R. uses.
   A. (a) A—Alco Products, Inc.
      (b) B—Baldwin-Lima-Hamilton Corporation.
      (c) E—Electro-Motive Division of General Motors Corporation.
      (d) F—Fairbanks, Morse and Company.
      (e) G—General Electric Company.
      (f) L—Lima-Hamilton Corp.
106. Q. What does the second, and third letter where used, designate on diesel locomotives?

A. The second letter, and third letter where used, designates service.
   (a) F—Freight.
   (b) H—Freight with lower speed gearing, primarily for helper service.
   (c) FP—Normally freight, but equipped for use in passenger service.
   (d) P—Passenger.
   (e) S—Switching service.
   (f) FS—Switching locomotives, equipped for use in freight service.
   (g) PS—Switching locomotives, equipped for use in passenger service.

107. Q. What do the numbers indicate when used in connection with the letters?

A. Horsepower in hundreds, such as:
   (a) 4—380 or 400 hp
   (b) 6—600 or 660 hp
   (c) 7—750 or 800 hp
   (d) 15—1500 hp
   (e) 17—1750 hp
   (f) 22—2250 hp
   (g) 45—4500 hp (2—2250 hp units or 3—1500 hp units)
   (h) 52—5250 hp (3—1750 hp units)

108. Q. What does the final letter, or letters, indicate when used in connection with the letters and numbers in advance?

A. The final letter, or letters, indicates special features.
   (a) a—Change in original design.
   (b) m—Multiple Unit equipped—Switchers.
   (c) s—Steam Generator equipped—Switchers.
   (d) z—Indicates major changes.

109. Q. What is the “prime-mover” on a diesel-electric locomotive?

A. The diesel engine.
110. Q. What is a diesel engine?
   A. An internal combustion, compression-ignition, fuel oil burning engine. An internal combustion engine is one that derives its power from the burning of a charge of fuel inside the cylinders. Compression-ignition means that the charge of fuel is ignited by coming into contact with highly compressed, and hence highly heated air, in the combustion chambers of the cylinders. This is the main distinguishing feature between the diesel and other internal combustion engines where ignition is achieved by the use of an electric spark or a "hot-spot".

111. Q. What is the normal operating temperature range of the engine cooling water?
   A. Between 140° and 185° F.

112. Q. After determining that a hot engine condition exists, how is the affected engine located?
   A. By observing the indication on the cooling water temperature gauge, or the lube oil temperature gauge if equipped, on each engine of the locomotive.

113. Q. What is the normal operating temperature of the engine lube oil?
   A. Approximately 20° F. higher than the engine cooling water.

114. Q. How is engine lube oil pressure determined?
   A. By observing the indication on the lube oil pressure gauge while the engine is running.

115. Q. What indicates that the ground relay has tripped and what procedure is followed in resetting it?
   A. Tripping of the ground relay is indicated by a red target only on the ground relay on some units. On other units, an alarm light and/or bell provide this indication. When resetting the ground relay, first, isolate the affected engine; second, reset the relay; third, place engine back on the line.

116. Q. What is the maximum number of times the ground relay may be reset during a tour of duty?
A. Three (3) times. The ground relay cut-out switch must not be opened. This is very important.

117. Q. What is the purpose of fuses on the locomotive?
A. To protect the low voltage circuits against overloads or short circuits.

118. Q. What type of device is used on some locomotives instead of fuses?
A. Thermal overload circuit breakers having three positions; “Off”, “Tripped”, and “On”. If found in the “Tripped” position, they can be reset by moving handle to full “Off” position and returning to “On” position.

119. Q. What should be done if an engine is stopped by an overspeed trip actuation?
A. (a) Isolate affected engine.
(b) Reset overspeed trip.
(c) Restart engine.
(d) Place engine back on line.

120. Q. What items should be checked and in what order if engine has stopped due to operation of a protective device or other cause resulting in “low oil alarm”?
A. (a) Fuel flow.
(b) Overspeed trip.
(c) Ground relay.
(d) Lube oil.

121. Q. What inspections should be made of a diesel-electric locomotive when beginning a tour of duty?
A. (a) Make general inspection of the locomotive. If locomotive consists of several units, see that all electrical jumpers and all air hoses, and CO₂ jumpers where equipped, are connected between units and air cocks open; and, on passenger locomotives, see that steam heat connections between units are made and valves open.
(b) See that lubricating oil, fuel oil, cooling water, and steam generator water supply when required, are at required level.
(c) See that required supplies of flagging equipment, tools, spare fuses, etc., are on the locomotive.

(d) If engines are shut down, instructions on starting engines must be followed.

(e) If engines are running, note position of isolation switches or engine control knobs.

(f) If any engine is shut down and tagged "DO NOT START", no attempt should be made to start engine.

(g) See that condensation is drained from all air reservoirs.

(h) See that drains are closed on air reservoirs, cooling water, and lubricating oil systems.

(i) See that all outside connections (steam, fuel, water, or electrical) are disconnected and clear of locomotive.

122. Q. What must be checked before starting a diesel engine when preparing a locomotive for service (a) at the engineman’s control position and (b) at the electrical cabinet?

122. A. (a) At Engineman’s control position:

1. Throttle lever in "Idle" position.
2. Reverse lever in "Off" position.
3. Transition lever (where equipped) in "Off" position.
4. Close control switch, and fuel pump switch where provided.
5. Check that generator field (locomotive run) and engine run switches are open on classes so equipped.

(b) At the electrical cabinet:

1. Check that all fuses are in place and switches and circuit breakers closed.
2. Battery switch must be closed.

123. Q. What is the general procedure to be followed in starting a diesel engine?

A. (a) Place isolation switch (engine control switch) in "Start" ("Idle") position. On locomotives
not equipped with this switch, throttle lever must be in “Idle” position and reverse lever in “Off” position.

(b) Close fuel pump switch.
(c) Check to see that fuel is being delivered to the engine by observing fuel pressure gauge or sight glass.
(d) Operate starting control to crank engine, holding closed until engine fires and lube oil pressure attains required value. Engine should start within 10 seconds. Do not drain battery for a prolonged time.

124. Q. What checks should be made after starting a diesel engine?

A. (a) See that starting contactors are open.
(b) Check ground relay and reset if tripped.
(c) See that battery charging indicator shows charge.
(d) Make general check of engine for any unusual conditions.

125. Q. What is the general procedure to be followed in placing a diesel engine on the line in multiple unit operation?

A. Place isolation switch (engine control switch) in running position. On some units, while this is being done, it may be necessary to retard the movement of the layshaft manual control lever, while on other units to advance engine control switch gradually to running position, so that engine will come up to speed gradually if throttle is open.

126. Q. What is the general procedure to be followed in isolating a diesel engine?

A. Place isolation switch (engine control switch) in “Start” (“Idle”) position. On some units, while this is being done, it may be necessary to reduce engine speed through the use of the layshaft manual control lever, and on other units to move engine control switch gradually to “Idle” position, so that engine will reduce to idle speed gradually if throttle is open.
127. Q. What is the normal procedure to be followed in shutting down a diesel engine?

A. If an engine is to be stopped it should first be isolated and then the stop switch, or button where provided, should be operated, or the engine control switch turned to the "Off" position on locomotives so equipped. After the engine has stopped the fuel pump switch should be placed in the "Off" position.

128. Q. What is the procedure to be followed in shutting down all diesel engines on a locomotive in an emergency?

A. The emergency engine stop is operated by pushing the stop button on some classes, while on other classes the throttle lever incorporates a "Stop" position beyond the "Idle" position which is made available by an unlatch mechanism on the throttle lever. When the emergency engine stop is operated, all diesel engines on the locomotive will stop. Care must be exercised to prevent operating the emergency engine stop except in emergency.

129. Q. What checks should be made to see that all diesel engines are "on the line?"

A. See that all engines are on the line by opening throttle, with reverse lever in "Off" position and generator field (locomotive run) switch open on locomotives so equipped, checking each diesel engine to see that it is running at a speed corresponding to throttle position.

130. Q. What is the general procedure to be followed in moving a locomotive?

A. (a) Before attempting to move locomotive, see that chocks or chains are removed from under the wheels, and that the hand brakes are fully released on all units after main reservoir pressure has reached at least 100 psi.

(b) Close generator field (locomotive run) switch where provided.

(c) Place reverse lever in "Forward" or "Reverse" position.
(d) Place transition lever, where provided, in #1 position.
(e) Hold either deadman pedal or automatic brake valve handle in depressed position to prevent deadman operation, when equipped.
(f) Release air brakes.
(g) Open throttle to 1st notch and note that amperage is indicated on load ammeter.
(h) Further movement of throttle lever depends on proper handling of train due to slack action and permissible speed.

131. Q. What procedure is to be followed in reversing a diesel-electric locomotive?
A. (a) Bring locomotive to a full stop.
   (b) Leave brakes applied, move reverse lever to opposite direction.
   (c) Release brakes.
   (d) Open throttle as required.

132. Q. What action should be taken when leaving a locomotive unattended?
A. Check to see that throttle lever is in “Idle” position and reverse lever removed in “Off” position. Air brakes should be released, hand brakes applied, and when necessary, the wheels should be chocked. If required by special instructions, all diesel engines should be shut down and lighting switches and battery switch opened.

133. Q. What comprises the fire fighting equipment on road locomotives?
A. The fire fighting equipment on road locomotives consists of two (2) sets of two (2) 50 lb. capacity carbon dioxide cylinders in each engine room, two (2) hose stations on each side of each locomotive unit—One (1) near the front and one (1) near the rear of each side, and two (2) remote control pull boxes mounted near each hose station and connected by steel cables to the control heads on the cylinders, one (1) box mounted inside the unit near the hose rack and one (1) outside within reach of ground.
Each hose station is equipped with fifty (50) ft. of hose complete with discharge horn and squeeze-grip discharge valve. The pull boxes are so connected to the two (2) sets of cylinders in each locomotive unit that both sets can be operated from either side of the unit. The carbon dioxide system on each locomotive unit is supplemented by two (2) 30 lb. Dugas hand extinguishers, primarily for use on outside fires and not to be used inside unless fire is not extinguished by the carbon dioxide system.

134. Q. In case of fire, how should fire fighting equipment be used on road locomotives?

A. Carbon-dioxide system should be used on all fires inside or outside: will not harm apparatus. Water should be used only as last resort and then preferably with fog nozzles. Carbon-dioxide in addition to its extreme cooling effect and fire extinguishing ability can be used to drive back smoke, permitting access to the fire.

(a) To operate—open a pull box and pull handle hard; next throw lever of valve at hose rack to be used up and over to the left (counter-clockwise). Pull boxes are located inside units near hose connections and outside at sill near each end of unit. Take hose discharge horn as close as possible to fire. Hose racks are located near doors and ends of units.

(b) Direct horn at base of flames, squeeze horn control valve to release carbon-dioxide gas as necessary to dissipate heat and extinguish fire.

(c) Operation (a) will discharge two (2) of the four (4) cylinders in the diesel unit; to obtain gas from other cylinders, pull additional handles until obtained.

(d) To obtain gas from cylinders in adjoining unit, lever of valve above door in end of adjoining unit must be thrown up and over to left (counter-clockwise); then operate pull boxes, in this unit, as heretofore described. Repeat for other units if necessary.
(e) After any fire has been extinguished, turn all valve levers (clockwise) to closed position; bleed hose line of gas by squeezing valve at horn.

Note: Units of class BH-50 are inter-connected for delivery of carbon-dioxide to either unit, but do not have throw lever valves between units. Some locomotives have a fixed discharge nozzle in the electrical cabinets. In case of fire in these cabinets, operate pull boxes as described above, and throw lever of valve for cabinet concerned up and over to left (counter-clockwise).

DRY POWDER EXTINGUISHER—Primarily for fires on outside. Not to be used inside unless fire is not extinguished by carbon-dioxide system.

Each unit has two (2) dry powder extinguishers—"A" units have one in engineman's cab and one in engine room—"B" units have two in engine room.

Remove extinguisher from holder. Remove ringpin from lever and push lever down hard. Take extinguisher as close as possible to fire and direct nozzle at base of flames, squeeze nozzle handle. Release extinguishing agent as necessary.

Report fire and use of extinguishing equipment on Form MP-62-DE.

135. Q. What comprises the fire fighting equipment on switcher type locomotives?

A. The fire fighting equipment on switcher type locomotives consists of two (2) or three (3) 20 lb. carbon-dioxide portable fire extinguishers, depending on hood arrangement of the locomotive unit. On single hood units, one (1) extinguisher is located in the cab, and one (1) under the engine hood on the left side of the locomotive. On double hood units, one (1) extinguisher is located in the cab, and one (1) under each hood. The location
of extinguishers in the hoods is indicated by the words "Fire Extinguisher", in white letters, on the outside surface of the adjacent hood door.

136. Q. In case of fire, how should fire fighting equipment be used on switcher type locomotives?

A. These extinguishers are to be used for all fires on or about the locomotive. Carbon-dioxide will not harm any of the apparatus and is also safe to use on live electrical equipment. Water should never be used on live electrical equipment but may be used on dead electrical equipment and other apparatus as a last resort, and then preferably with fog nozzles.

In case of fire:
(a) Remove extinguisher from bracket by grasping carrying handle provided at top of cylinder with palm of the hand above the operating lever, and carry to point where it is to be used.
(b) Remove operating lever locking pin and grasp discharge horn.
(c) Release carbon-dioxide by squeezing operating lever.
(d) Direct horn discharge of carbon-dioxide snow at base of nearest part of fire. Progressively extinguish fire by slowly playing discharge from horn over burning area. Continue discharging snow on burned areas after fire is extinguished to prevent flare-ups. In case of spreading oil fires on floor or ground, slowly advance as the flame is extinguished while slowly moving discharge horn from side to side. BE SURE ALL FLAME IS OUT IN THE AREA COVERED BEFORE ADVANCING
(e) Stop discharge of carbon-dioxide by releasing hand pressure on operating lever.
(f) Promptly report fire and use of extinguisher on Form MP-62-DE.

137. Q. What precaution must be taken when using the carbon-dioxide fire extinguishing system?

A. Carbon-dioxide is a non-conductor of electricity, which makes its use desirable in combating elec-
trical fires, and is not poisonous. However, it does not carry oxygen in any form for sustaining human life and when there is any question as to the amount of carbon-dioxide in a confined space where a fire has been extinguished, care should be exercised before entering to see that the space is completely ventilated.

Anyone overcome by carbon-dioxide should be moved quickly into fresh air and artificial respiration applied.

138. Q. What procedure should be followed in starting the steam generator?

A. (a) Open steam separator blowdown valve and latch in open position; also open fill-test valve.

(b) Check reset buttons on stack switch and control panel.

(c) Check position of all valves. Water supply stop valves and atomizing air shut off valves must be open, and coil blowdown valve must be closed.

(d) When steam separator is fully drained, close steam separator blowdown valve.

(e) Close main switch and turn control switch to "Fill".

(f) Check ignition spark by observing through sight glass.

(g) When water discharges from fill-test valve, turn control switch to "Off"; close fill-test valve and latch the steam separator blowdown valve open.

(h) After motor has stopped, turn control switch to "Run"—fire should light immediately.

(i) Check water pressure and fuel manifold and fuel nozzle pressure.

(j) When generator steam pressure reaches 50 lbs., close separator blowdown valve.

(k) When generator steam pressure reaches 100 lbs., open steam trainline stop valve gradually until fully open.
139. Q. What attention should be given the steam generator while in operation enroute?

A. (a) The steam separator should be blown down at every 45 minutes for a period of 3 to 5 seconds.
(b) Handle on fuel oil knife edge suction filter should be rotated several turns in a clockwise direction at beginning of trip and at intermediate terminal points.

140. Q. What procedure should be followed in shutting down the steam generator?

A. (a) Close steam train line stop valve.
(b) Place control switch in “Off” position.
(c) Open coil blowdown valve—reducing generator steam pressure to 50 pounds.
(d) Close coil blowdown valve.
(e) Open separator blowdown valve and latch in open position until all pressure is released.
(f) Close separator blowdown valve.
(g) Fill coils with water as described for starting steam generator.
(h) Place control switch in “Off” position.
(i) Open main switch.
(j) Close atomizing air valve.
201. Q. What is essential to safety and efficiency in operation?
A. Obedience to the Safety and Operating Rules.

202. Q. How is the power developed by the diesel engine used to propel the locomotive?
A. The engine drives a direct-current main generator through a crankshaft connection. The electric power from this generator is transmitted by power cables to the traction motors which are geared to the driving axles on the trucks. The cables provide a path or circuit for the electric current. Connection of the power circuit from the main generator to the traction motors is completed through power switches known as "contactors".

203. Q. What furnishes the power to start the diesel engine?
A. The storage battery.

204. Q. How is the rotative speed of the diesel engine controlled?
A. By a governor mounted on the engine which controls the rotative speed of the engine at a setting determined by the position of the throttle lever at the engineman's control stand. The engineman's throttle lever controls the speed setting of the governor through a system of either direct mechanical, electro-pneumatic, electro-hydraulic, or straight pneumatic linkage to the governor. The governor, in all cases, is mechanically connected to the fuel injection system of the engine so that it can vary the amount of fuel injected into the cylinders.

205. Q. What happens if the governor fails to limit the maximum speed of the diesel engine?
A. An overspeed stop mechanism will automatically shut the engine down if its speed goes approximately 10% above the maximum governed speed. The overspeed stop device is located on the engine and...
it must be manually reset before the engine can be started after an overspeed shutdown.

206. Q. What is the function of the diesel engine fuel oil system?
   A. To supply fuel oil under pressure to the engine cylinders.

207. Q. What are the principal parts of the fuel oil system?
   A. The system consists of a supply tank, transfer pump, fuel injection pumps and injectors, filters and the necessary piping, valves, gauges, and fill, vent, and drain connections.

208. Q. How is the fuel oil supply shut off in case of fire or other emergency?
   A. By shutting off the fuel oil pump or by tripping the emergency fuel cut-off valve.

209. Q. What is the emergency fuel cut-off valve and where is it located?
   A. It is a spring-loaded valve located in the suction line between the fuel oil tank and the fuel transfer pump.

210. Q. How is the emergency fuel cut-off valve tripped and how is it reset?
   A. This valve is tripped closed through connections to pull handles at various locations on the locomotive unit and, if tripped, must be reset manually to the open position. To reset, the valve stem must be raised and the crutch placed in position to hold the valve open.

211. Q. What is the function of the diesel engine lubricating oil system?
   A. To supply lubricating oil, under pressure, to the working parts of the engine and associated equipment.

212. Q. What are the principal parts of the diesel engine lubricating system?
   A. The system consists of a storage chamber, suction and pressure circulating pumps mounted on and driven by the engine, strainers and filters, cooler and the necessary piping, valves, gauges and fill and drain connections.
213. Q. How is the diesel engine protected in the event of a failure in the lubricating oil system?
A. (a) A lubricating oil pressure switch, or switches, is located in the lube oil header which, when actuated due to low lube oil pressure, shuts down, or idles, the engine and actuates the alarm circuit.
(b) On engines with governors equipped with a governor safety control device, this device acts (in lieu of the pressure switches in the lube oil header) to energize the alarm circuits, shut the engine down, and move a pushbutton in the body of the governor out approximately $\frac{3}{8}''$. This pushbutton must be reset before attempting to start the diesel engine.

214. Q. What is the function of the diesel engine cooling system?
A. To disperse, by the circulation of cooling water, the excess heat generated inside the engine.

215. Q. What are the principal parts of the diesel engine cooling system?
A. The system consists of an expansion or storage chamber, a circulating pump mounted on and driven by the engine, circulating passages in the engine, radiators through which air is drawn by mechanically or motor-driven fans, radiator shutters to control air flow, and the necessary piping, gauges, valves and fill, vent and drain connections.

216. Q. How is the temperature of the diesel engine cooling water system controlled?
A. Water is circulated through the engine, heat exchanger, and cooling radiators by the engine driven pump. Temperature of the cooling water is regulated by the action of the cooling fans and shutters. This action is normally automatic, but manual operation is provided should the automatic control fail.

217. Q. How is the operation of the fans and shutters controlled?
A. By thermostatic devices actuated by the engine cooling water temperature.
218. Q. What happens when a diesel engine becomes overheated?

A. A thermal element in the cooling water system actuates an engine high temperature switch, energizing the alarm circuits. On some locomotive classes, engine speed is reduced to idle. On certain classes, either high water or high oil temperature will sound the alarm and idle the engines.

219. Q. What is the source of compressed air on a diesel locomotive?

A. Each diesel engine drives a two-stage air compressor which takes air from the atmosphere and delivers it under pressure to the main reservoirs where it is stored and cooled.

220. Q. What uses are made of compressed air on the locomotives?

A. From the main reservoirs the compressed air is piped to the air brake system, communicating signal system where equipped, the air control system, and to other air-operated devices on the locomotive (horn, bell, sanders, windshield wipers, etc.).

221. Q. How can air be pumped faster, if necessary, when the locomotive is standing?

A. If necessary to pump air faster when locomotive is standing, place reverse lever in "Off" position and open generator field (locomotive run) switch, on locomotives so equipped, and advance throttle lever sufficiently to obtain pumping rate required.

222. Q. What are the primary functions of the main generator?

A. To supply power to the traction motors and to act as a starting motor for cranking the diesel engine and as an exciter for dynamic braking, where equipped.

223. Q. How is power developed by the main generator?

A. The diesel engine rotates the armature of the main generator through a magnetic field set up by excitation current flowing in the field coils of the
generator, producing power at the generator terminals.

224. Q. From what source does the main generator receive its excitation current?
   A. From the battery or an exciter generator.

225. Q. Why is the load on the main generator controlled and how is this accomplished?
   A. Since the governor limits the speed, and hence the horsepower output, of the diesel engine to a definite value for each throttle lever position, the power output of the main generator must also be limited to match the output of the engine or the engine will be unable to maintain its speed.

On a diesel-electric locomotive a load control is incorporated with the governor providing a system that will hold engine speed constant regardless of load applied. When the load applied tends to become greater than the diesel engine can handle, the load control system reduces the load to maximum capacity of the engine by automatically reducing the exciting current through the field windings of the main generator.

226. Q. On locomotives equipped for multiple-unit operation, what functions does the isolation switch (engine control switch) perform?
   A. When placed in “Start” (“Idle”) position, the diesel engine will run at idle speed only and will not provide power for the locomotive. When placed in a running position, the diesel engine is under the control of the engineman’s throttle lever.

227. Q. How are the radiator cooling fans driven?
   A. On some locomotives an alternating-current generator (alternator), driven by the diesel engine, supplies power for the engine radiator cooling fan motors. On the other classes of locomotives the engine radiator cooling fans are motor operated by power from the main generator, a fan and blower generator, or are mechanically driven by the diesel engine.

228. Q. How are the traction motors cooled?
   A. By traction motor blowers which are electrically
—or mechanically—driven depending on the class of locomotive.

229. Q. What would result if the locomotive were operated under load with traction motor blowers inoperative?

A. The traction motors would be overheated and seriously damaged.

230. Q. What is the purpose of the auxiliary generator?

A. The auxiliary generator charges the storage batteries in addition to supplying low voltage power for excitation and control apparatus, auxiliaries, and lighting while the diesel engine is running.

231. Q. What is the purpose of the motor generator (m-g) set, where equipped?

A. The m-g set provides a well regulated supply of 32 volts d-c for the operation of trainphone and cab signals. On some classes of locomotives, this power is also used to operate the headlights.

232. Q. What are the main electrical control circuits on a diesel-electric locomotive and what functions do they perform?

A. The main electrical control circuits are low voltage circuits, energized by the auxiliary generator, which establish control of the following functions:
   (a) Engine speed, when electrically controlled.
   (b) Main generator excitation.
   (c) Operation of power contactors.
   (d) Direction of traction motor rotation.
   (e) Dynamic braking.
   (f) Transition and field shunting.
   (g) Protective and alarm circuits.

233. Q. What method is used to control the power from all engines from one location?

A. A multiple-unit control system which permits control of all engines of the complete locomotive from one engineman's control stand. Where the locomotive consists of two or more coupled units, this control system is completed through jumper cables connected between the units.
234. Q. What is transition and why is it used?
   A. The switching of traction motor circuits as locomotive speed increases or decreases so that full power may be obtained from the main generator within the range of its current and voltage limits. Transition is controlled automatically or manually, depending on the class of locomotive.

235. Q. What is the effect of transition from series to parallel?
   A. As locomotive speed increases, traction motor current will decrease. By switching from series to parallel, the motor current will increase and restore full utilization of diesel engine output.

236. Q. What is traction motor field shunting and why is it used?
   A. It is the by-passing of a portion of the traction motor field current through resistors when field shunting contactors close at higher speeds. This action is similar to transition from series to parallel in that the traction motor current will increase and fully utilize diesel engine output.

237. Q. What is dynamic braking?
   A. A means of retarding the locomotive by which the traction motors are used to produce braking instead of pulling effort. The motors are reconnected as generators, operated by the energy of the moving locomotive, and the power produced by them is dissipated as heat by fan-blown resistors.

238. Q. On what wheels is dynamic braking effective and how is it controlled?
   A. Dynamic braking is effective only on the wheels of the locomotive which have traction motors. On classes having dynamic braking, where a transition lever is used, the amount of dynamic braking power is controlled by the position in its braking range of the transition lever, and, where no transition lever is provided, the reverse lever on the selector handle has a dynamic braking position and braking power is controlled by the throttle lever.

239. Q. What is the purpose of the dynamic brake interlock?
   A. The purpose of the dynamic brake interlock is to
prevent brake cylinder pressure on the locomotive when the automatic brake is applied during dynamic braking and to release any automatic application of the locomotive brake that may be effective when dynamic brake is applied. This does not affect the application of the independent brake or emergency application of the automatic brake. However, the independent brake must not be applied while using dynamic brake as it may cause locomotive wheels to slide.

240. Q. How is dynamic braking affected by speed?
   A. As the locomotive slows down, the slower speed of the traction motors reduces the amount of power generated and consequently the braking effect of the dynamic brake decreases, so that it is not practical to stop a train with the dynamic brake. During dynamic braking poor adhesion may cause the locomotive wheels to rotate slower than train speed. This also will reduce the effect of the dynamic brake.

241. Q. What restrictions apply to the amount of dynamic braking used?
   A. In order to prevent overloading of the traction motors, dynamic braking must be limited to the amount of current which can be carried safely by the motors as indicated on the loadmeter. A dynamic brake warning light will light if maximum permissible current is exceeded on any unit. When this occurs, braking effort should be reduced until the light goes out.

242. Q. What device is provided to indicate the amount of electric current passing through the traction motors?
   A. A load indicating ammeter, or loadmeter, at the engineman’s position. This device must be used as a guide in the operation of the throttle lever and transition lever during motoring and dynamic braking.

243. Q. What information is derived from observing the loadmeter during (a) motoring and (b) dynamic braking?

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A. (a) Motoring
(1) It provides an indication of the proper load conditions and acts as a guide to avoid overloading the traction motors and main generator.
(2) It shows the proper position of the transition lever on classes equipped with manual transition. With automatic transition, it indicates whether or not transition is functioning properly.

(b) Braking
(1) It provides an indication of the amount of braking current being generated by the traction motors. Maximum permissible braking current is indicated by a mark on the meter dial.

244. Q. What precaution should be taken when replacing blown fuses or reclosing tripped circuit breakers?
A. Isolate or idle the engine before replacing battery field or main control fuse. Open auxiliary generator switch before replacing battery charging fuse. Shut engine down to replace alternator field, auxiliary generator field, or radiator fan fuses. See that any replaced fuse is of the correct amperage. These precautions need not be taken when resetting tripped circuit breakers. However, after a circuit breaker has tripped, a short time interval should elapse before attempting to reset the breaker to permit the thermal element to cool; otherwise, it will not remain closed.

245. Q. What is the purpose of the ground relay?
A. In case of a ground in the electrical circuits, the ground relay will act to remove power and prevent extensive damage to the electrical apparatus.

246. Q. How is wheel slip indicated and what action should be taken?
A. When wheel slipping occurs, wheel slip relays operate to reduce the power output of the diesel engines and light an indicating light, operate a buzzer, or both. When wheel slipping stops, the relays reset automatically. If slipping continues,
throttle lever position should be reduced. If wheel slip indication is continuous, check wheels for rotation.

247. Q. Should sand be used to stop wheel slip?
   A. No. Throttle should be reduced to stop wheel slipping before sand is applied. Sand should be used to prevent slipping, not to stop it.

248. Q. What are the functions of the air control system on diesel-electric locomotives and what pressure is used?
   A. The air control system furnishes control air pressure which is used to operate the various electro-pneumatic contactors, reversers, and cam switches on the locomotive. A control air pressure of 90 psi is used.

249. Q. What comprises the safety control system on locomotives so equipped and what functions does it perform?
   A. The safety control system includes dead-man and locomotive overspeed features to apply the brakes and reduce the power output of the diesel engines should the engineman become incapacitated or the maximum permissible speed of the locomotive be exceeded.

A safety control application, as well as a train speed control application or a brake valve initiated emergency application, of the brakes operates a pneumatically controlled switch (PC or power knockout) to reduce engine speed to idle and requires that the throttle lever be placed in "Idle" position and brake pipe pressure restored before power can be reapplied.

250. Q. How is main reservoir pressure controlled?
   A. (a) On locomotives equipped for multiple-unit operation, main reservoir pressure is controlled by an electrically-actuated governor set to cut in at 130 lbs. pressure and to cut out at 140 lbs. pressure.
   (b) On locomotives not equipped to multiple, main reservoir pressure is controlled by a pneumatically-actuated governor which main-
251. Q. Is the combined capacity of the several compressors available for use on all units in multiple-unit operation?
A. Yes. The main reservoir air is connected between units by flexible hose connections so that the combined capacity of the several air compressors, as well as the combined volumes of the several main reservoirs, are available throughout the entire locomotive.

252. Q. What is the purpose of the steam generator?
A. To provide steam to the steam trainline to heat the train, for dining car purposes, to actuate steam-jet air-conditioning, and to heat water throughout the train for passenger use.

253. Q. What must be supplied to the steam generator to make it function?
A. (a) Water from supply tank.
(b) Fuel oil from diesel engine fuel oil supply tank.
(c) Compressed air from main reservoirs.
(d) Electricity from auxiliary generator.
(e) Combustion air from the atmosphere.

254. Q. How is the steam output of the steam generator controlled?
A. The steam output of the steam generator is automatically controlled, in accordance with the demand, by a water bypass regulator which bypasses a varying amount of the water from the pump and thus regulates the amount being delivered to the coils.

255. Q. How is the steam trainline pressure regulated?
A. The steam trainline pressure is regulated automatically by a predetermined setting of the water by-pass regulator.

256. Q. What are the functions of the servo-fuel control?
A. The amount of fuel delivered to the burner is regulated by the water-operated servo-fuel control in proportion to the amount of water entering the
steam generating coils. To proportion the amount of combustion air to the firebox, the servo-fuel control is linked to a damper in the air intake stack.

257. Q. What are the functions of the steam generator motor?
A. The motor drives the water pump, fuel pump, and blower and furnishes alternating current to a transformer for the electric ignition.

258. Q. What is the source of electrical power for operation of the steam generator?
A. The battery or auxiliary generator through a main switch located on or adjacent to the steam generator.

259. Q. What safety and protective devices are provided on the steam generator?
A. (a) Stack temperature switch.
   (b) Motor overload relay.
   (c) Low water shutdown switch. (Servo cutout switch)
   (d) Outfire relay.
   (e) High steam temperature limit control.
   (f) Coil blowdown valve switch.
   (g) Safety relief valves.
   (h) Fuses.

260. Q. What fuses are located in the steam generator control panel?
A. Four 15-ampere fuses, two in the control circuit and two in the ignition circuit are located in the control panel and protect their respective circuits from overload.

261. Q. What is the purpose of the motor overload relay?
A. The motor overload relay shuts down the steam generator and actuates the alarm circuit in the event of excessive load on the motor. The relay must be reset by hand.

262. Q. What is the purpose of the high temperature stack switch?
A. The high temperature stack switch cuts off fuel to the steam generator and actuates the alarm circuit
when stack temperature exceeds 900° F. The switch must be reset by hand.

263. Q. What is the purpose of the water pump test valve?
A. The water pump test valve, located in the discharge pipe at the water pump, may be used to determine if the pump is delivering water.

264. Q. What is the purpose of the coil blowdown valve and switch?
A. A coil blowdown valve is provided to blow out sludge and water when shutting down the steam generator. A switch, incorporated in this valve, prevents operation of the motor and actuates the alarm circuit unless the coil blowdown valve is closed.

265. Q. What gauges are associated with the operation of the steam generator?
A. (a) Manifold fuel pressure
(b) Nozzle fuel pressure
(c) Steam trainline pressure
(d) Steam generator pressure
(e) Atomizing air pressure
(f) Water pressure

266. Q. What precautions must be observed before operating coil blowdown, separator blowdown, or blowing out of steam trainline?
A. Ascertain that no person is in a position where the steam will contact him. These operations must not be performed while locomotive is in station territory.

267. Q. What is the purpose of the steam separator?
A. The steam separator, located between the steam generator and the steam trainline stop valve, separates the excess water from the steam for return to the water supply tank. It also removes solids from the steam into a sump that is blown out when the separator is blown down.

268. Q. What is the purpose of the return water flow indicator?
A. The return water flow indicator indicates that
excess water from the steam separator is being returned to the supply tank. After the steam generator settles to a steady output, the indicator should cycle 4 to 12 times a minute, which indicates that the servo is properly set to provide saturated steam.

269. Q. When it is necessary to shut off steam supply to steam train line for a short time, what procedure should be followed?

A. Close steam generator stop valve at all steam generators which are operating.

270. Q. During freezing weather, what precautions must be taken to prevent water supply tank and idle steam generators from freezing?

A. During freezing weather steam pressure must be available in the steam trainline in order to protect water supply tanks and idle steam generators from freezing. If steam pressure is not available, the complete system and water supply tanks must be drained.
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301. Q. What restrictions apply to sealed valves, cocks, and switches?
   A. Sealed valves, cocks, and switches must not be operated except by specific special instructions or authorization. Any broken or missing seals must be noted on MP-62-DE report.

302. Q. What special precaution should be observed before attempting to start a diesel engine?
   A. Do not start a diesel engine which has been shut down for a defect. Check MP-62-DE report and red MP-415 tag at engine control panel.

303. Q. Under what type of abnormal conditions must a diesel engine be shut down and no attempt made to restart it?
   A. (a) Crankcase explosion.
      (b) Fire.
      (c) Broken fuel, oil, or water lines.
      (d) Unusual noise, smoke, or odor.

304. Q. If an engine has been shut down due to some internal breakdown or defect, what further action should be taken?
   A. Employees must immediately leave the engine room and no attempt should be made to remove the crankcase inspection covers.

305. Q. Under what type of abnormal conditions should a diesel engine not be shut down but should be isolated?
   A. (a) If a hot engine condition exists, attempts should be made to cool the engine by permitting it to idle. If the engine will not cool, shut it down.
      (b) The engine should be permitted to idle in order to keep the battery charged and to furnish compressed air under the following conditions:
(1) Repeated ground relay or engine over-speed operations.

(2) Traction motor blower failure.

306. Q. What should be done if main reservoir pressure is being lost in going down grades with the engine idling?

A. Open the generator field (locomotive run) switch where equipped, and where not equipped, the reverser handle must be moved to the "Off" position. Open the throttle sufficiently to maintain required main reservoir pressure. Do not fail to return the throttle to idle before closing the generator field (locomotive run) switch, and be certain, if reverser handle has been moved to "Off" position, it is placed in the position corresponding to train movement.

307. Q. In case of emergency, how may the air brakes be applied at other than the engineman's position?

A. By opening the valve labeled EMERGENCY BRAKE VALVE located in all operating cabs and adjacent to the end doors of all road passenger and freight locomotives.

308. Q. How should throttle be handled when passing over railroad crossings or drawbridges and why?

A. When passing over railroad crossings or drawbridges the throttle must be placed in a low notch to prevent arcing between the traction motor brushes and commutators.

309. Q. What restrictions apply to operating a locomotive through water?

A. A locomotive must not be operated through water deep enough to touch the traction motors. When passing through water to the level of the rail head, reduce speed to less than 5 mph.

310. Q. What restrictions apply to the operation of the reverse lever while the locomotive is in motion?

A. The reverse lever must not be moved to the position for operation in the opposite direction while
the locomotive is in motion except in the case of failure of brakes, which condition is covered by special instructions.

311. Q. What are the restrictions to braking with power applied?

A. In braking the train for slow-downs or stops, the brake may be applied while using power; however, the throttle lever should be placed in a lower notch while braking and power must be shut off before the stop is completed.

312. Q. What check must be made on a locomotive that is giving continuous wheel slip indication even though the throttle is reduced to overcome wheel slip?

A. Check all the locomotive wheels while moving slowly to see that all wheels are revolving as a traction motor may have locked. If the trouble cannot be located in this manner, isolate engines or cut out traction motors in turn until the defect is located.

313. Q. What should be done if locked wheels are found?

A. Move train slowly to nearest telephone and notify Superintendent for further instructions.

314. Q. When attempting to start a diesel engine and no fuel oil pressure obtains, or no fuel appears in the sight glass nearest the engine where equipped, what checks should be made?

A. (a) If fuel pump is not running:
   
   (1) Check emergency engine shut down switch and engine stop circuit breaker where equipped.
   
   (2) Check switches and fuses or circuit breakers in control and fuel pump circuits.
   
   (b) If fuel pump is running:

   (1) Check fuel supply.
   
   (2) Check emergency fuel cut-off valve.

315. Q. If engine does not rotate when starting control is operated, what checks should be made?
A. (a) Check to see that isolation (engine control) switch is in “Start” (“Idle”) position. On locomotives not equipped with this switch, see that throttle is in “Idle” position and reverse lever in “Off” position.

(b) Check starting fuses where equipped.

(c) Check starting contactors.

(d) Check to see that engine stop circuit breaker is “On”, where equipped.

(e) Check to see that governor circuit breaker is closed, where equipped.

316. Q. If diesel engine rotates but does not fire when starting control is operated, what checks should be made?

A. (a) Check overspeed stop and reset if necessary.

(b) Check governor oil supply.

(c) Check that governor reset push button, where equipped, is in.

(d) See that layshaft manual control lever, where equipped, is in or near “Idle” position.

(e) Where equipped with an electric governor, engine control switch must be in “Idle” position for approximately 10 seconds before starting control is operated.

317. Q. If locomotive fails to move when the throttle is opened with the diesel engines running, or if locomotive moves but one or more engines fail to deliver power, what checks should be made of (a) engineman’s controls, (b) other devices except fuses and circuit breakers, (c) fuses and circuit breakers, and (d) connections outside the locomotive?

A. (a) Engineman’s controls:

(1) Check that reverse lever is in proper position.

(2) Check that transition or selector lever is in proper position.
(3) Check that brakes are released.
(4) Check that generator field (locomotive run) and engine run switches are closed where equipped.
(5) Check that cutout cock in supply pipe to control stand is open on locomotives equipped with a pneumatic throttle.

(b) Other devices except fuses and circuit breakers:
(1) Check that isolation (engine control) switches are in “Run” position.
(2) Check ground relay.
(3) Check to see starting contactors are open.
(4) Check that PC (power knockout) switches are closed.
(5) Check air control reservoir pressure gauge.
(6) Check traction motor cutout switches where equipped.

(c) Fuses and circuit breakers:
(1) Check control fuses and circuit breakers.
(2) Check battery field, auxiliary generator field, and alternator field fuses where equipped.
(3) Check power cutout and exciter field circuit breakers where equipped.

(d) Connections outside the locomotive:
(1) Check that m-u jumper cables are installed.
(2) Check throttle pipe and m-u hoses for leaks on locomotives equipped with a pneumatic throttle.

318. Q. If engine shuts down due to low lube oil pressure, what checks should be made?
A. (a) Check lube oil level.
   (b) Check external lube oil piping for leaks.

319. Q. What should be done if engine lube oil pressure cannot be maintained above the safe minimum value or if lube oil level is low?
A. The engine should be shut down, properly tagged, and report made.
320. Q. Under normal conditions, what should be the temperature of the engine cooling water before load is applied?
   A. 125° F.

321. Q. In the event the "hot engine" alarm is actuated, what checks should be made?
   A. (a) Check water supply.
      (b) Check shutter position. If closed, position shutters manually where possible.
      (c) Check operation of cooling fans. If fans are not running, check the following depending upon class of unit:
         (1) Fan circuit breaker.
         (2) Fan and blower generator fuse.
         (3) Alternator field fuse.
         (4) Radiator fan control switch.

322. Q. What should be done if engine cooling water temperature cannot be reduced below the safe maximum value or if cooling water level is below minimum?
   A. The engine should be shut down, properly tagged, and report made.

323. Q. If ground relay fails to remain reset, what action should be taken?
   A. If the trouble cannot be cleared up, isolate the affected unit. In any event, check to see that the locomotive wheels are free to rotate, as a traction motor may have locked.

324. Q. What is the effect of a failure of the alternator on locomotives so equipped and what action should be taken?
   A. Should the alternator fail, the engine will return to idle and the alarm circuit actuate. Place isolation (engine control) switch in "Start" ("Idle") position to stop alarm and check alternator field fuse or circuit breaker and auxiliary generator field fuse or switch.

325. Q. Why is it necessary to check the battery charging indicator frequently?
A. To know that the auxiliary generator is charging the battery.

326. Q. What will occur if the auxiliary generator is not charging the battery?
A. A low battery voltage will result which will cause eventual loss of operating and safety controls. If a diesel engine should shut down, a weak battery may prevent starting. On some classes, failure of the auxiliary generator will return the engine to idle at once.

327. Q. If battery charging indicator shows discharge with engine running, what action should be taken?
A. (a) Check auxiliary generator fuse or switch.
(b) Check auxiliary generator field fuse or switch.

328. Q. If a traction motor blower fails, what action should be taken?
A. Check the following where applicable:
(a) Blower generator and blower generator field circuit breakers.
(b) Blower motor fuses.
(c) Alternator field fuse or circuit breaker and auxiliary generator and auxiliary generator field fuses.
If traction motor blowers remain inoperative, isolate the diesel engine.

329. Q. What is the purpose of the unit selector switch, where used, on locomotives equipped for dynamic braking?
A. The purpose of the unit selector switch is to equalize the excitation current of the main generator fields throughout the locomotive during dynamic braking.

330. Q. Should this switch be changed when an engine is shut down or off the line?
A. No. The position of this switch is determined by the total number of units and not by the number of units operating.

331. Q. When is it necessary to change the position of this switch?
A. The unit selector switch should be positioned when the locomotive is dispatched. It should not be changed enroute unless units are added to or cut off from the original consist of the locomotive.

332. Q. If locomotive operates properly under power but will not provide dynamic braking, what may be the cause?

A. Check the following where applicable:
(a) Field loop jumper not coupled between units.
(b) Field loop jumper left in receptacle on front or rear end of locomotive.
(c) Dynamic brake cutout switch “Off”.
(d) Dynamic brake circuit breaker on operating unit tripped or in “Off” position.

333. Q. What damage is likely to occur if the wheels are allowed to slip excessively?

A. Traction motors may flash and trip the ground relay. Such flashovers may result in burning the commutators and brushholders and damaging the motor windings. In addition, excessive wheel tread wear and rail burns will result.

334. Q. If unable to recover after a safety control application of the brakes, what action should be taken?

A. If unable to recover a safety control application of the brakes or if safety control applications recur with the dead-man pedal held down and speed below maximum permitted, the safety features may be cut out, provided that the engineman is not alone in the operating end while the train is in motion. A report to the Superintendent must be made without delay to the train.

335. Q. What procedure should be followed in case of fire?

A. If fire is discovered, shut down diesel engines and make full service application of the brakes if not already done. Stop fuel pumps or pull emergency fuel cut-off on unit or units involved. Then use fire extinguishing equipment. A full report of the fire should be made.