Operating Instructions
for
Sugar Electric Locomotives
PREFACE

This book is printed as a guidance to engine drivers in the operation of Diesel Electric Locomotives.

Every engine driver to whom a copy of this book is issued must forthwith make himself fully conversant with, and will be responsible for compliance with, the instructions contained herein. He must have with him when on duty on diesel electric locomotives and produce when required, the copy issued.

Chief Mechanical Engineer.
**DIESEL-ELECTRIC LOCOMOTIVE OPERATING INSTRUCTIONS FOR DRIVERS.**

A copy of this book is to be issued to every employee qualified to drive a Diesel Electric Locomotive.

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This book has been prepared as a guidance to drivers in the duties expected of them under various operating conditions encountered in general service running with Diesel Electric Locomotives. It has been compiled with reference to the Clyde GM Operating Manuals for Diesel Locomotives and in conformity with local conditions and experience and supersedes previous instructions issued by memorandum.

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Section 1. TAKING OVER THE LOCOMOTIVE FOR SERVICE.

Under normal circumstances, the Locomotive will be running and roadworthy when taken over and the following will be the driver’s duties:

(a) Sign on.
(b) Peruse the Notice Board.
(c)Ascertain from the engine board the locomotive number, its location and time due at T.R. point.
(d) Obtain the reverser handle from the Officer-in-Charge or his deputy and walk to the Locomotive. The receipt of the reverser handle of the Locomotive from the Officer-in-Charge of the Diesel Shop or his deputy will be an assurance, that the locomotive is properly equipped and roadworthy.

NOTE. Drivers are not held responsible for the amount of fuel in the locomotive.

(e) Inspect the Vigilance Control, tool kit, and hand lamp.
(f) Enter names of crew in log book which is carried on each locomotive, and also the condition of the hand lamp.
(g) Make an application of the brakes and note the reaction of the gauges. Release hand brake.
(h) Move the locomotive out cautiously, driving from the leading end and early enough to reach the T.R. point at the required time.

Section 2. STABLING THE LOCOMOTIVE.

The following are the drivers’ duties when stabiling a locomotive at a Depot:

(a) At locations where fueling facilities are available enginemen are to fuel locomotives when directed to do so.
(b) Apply the hand brake.
(c) Switch Generator Field circuit breaker at the driver's control panel to OFF.
(d) Place reverser handle in Train Examiner's box, or hand to the Officer-in-Charge.
(e) Place the locomotive keys in the glove box.
(f) Walk to man-power office.
(g) Sign off.

Locomotives must be driven from the leading cab in the direction of movement except when the movement is controlled by a guard or shunter.

This direction also applies to Locomotives coupled in multiple.

Section 3. STOPPING THE ENGINE WHEN STABLING.

If the circumstances of arrival are such that the engine has to be stopped after stabling, the following duties, additional to those shown in Section 2 above, are to be observed:-

In the Engine Room. (In the Cab on T & Y Class Locos.)

(a) Place Isolating Switch to "Start" position.
(b) Press "Stop" button until engine dies completely.

In Driver's Cab.

(c) Switch Fuel Pump and Control Circuit Breakers on the Driver's Panel to OFF.
(d) On S Class Locos put the Engine Run and Control Circuit Breakers to OFF and on T & Y Class Locos put the Engine Run and Control Switches to OFF.
(e) Open Main Battery Switch in the Electrical Cabinet.
Section 4.  CHANGING ENDS.

When leaving Cab. (B Class).

(1) Remove reverser handle.
(2) Make full service brake application with automatic brake.
(3) Close brake valve isolating cock and remove both brake handles.
(4) Switch circuit breakers on driver's control panel to OFF.
(5) Switch off lights not required, close doors and windows.
(6) Walk through unit to opposite end.

(S Class).

(1) Remove the reverser handle.
(2) Make a full service brake application with the Automatic Brake.
(3) Close the Brake Valve isolating cock and remove both brake handles.
(4) Switch the circuit breakers on the driver's control panel to OFF.
(5) Switch off lights not required, close doors and windows.
(6) In the Electrical Cabinet put the Hostler switch to the "Hostler Control" position.
When entering Cab. (B Class).

(1) Switch circuit breakers on driver’s control panel ON as for normal operation.

(2) Switch on required lights.

(3) Insert reverser and brake valve handles and place dynamic brake handle to No. 1 position.

(4) Place independent brake handle in SLOW application position.

(5) Open brake valve isolating cock.

(6) Proceed with normal locomotive operation.

(S Class). Hostler Control End.

(1) Unlock the switches and push fully in the Control, Engine Run and Generator Field Switches.

(2) Switch on the required lights.

(3) Insert the Reverser Lever.

(4) Place the brake handles in position with the independent brake handle in the SLOW application position.

(5) Open the brake valve isolating cock.

(6) Proceed with normal operation.

The procedure for changing ends (with engine running) is the same for multiple unit operation, with the exception that with multiple unit operation, the brake handles are removed from the brake pedestal of the trailing unit and placed in the glove box at that end and the reverser lever is removed and placed in the Train Examiners box.
NOTE. The Hostler Control Switch on S Class Locos is not used when changing units but only when changing from the Main Control end to the Hostler Control end or Vice Versa.

Changing units where T & Y class locos are concerned is the same as for B class locos except that there is no dynamic brake.

NOTE. On Y class locos the Brake handle positions are different.

Section 5. RELIEVING IN YARD.

When the driver relieves another driver in the yard before the locomotive is coupled to the next train to be run, he must observe the following instructions:

(a) Inspect the hand lamp and note its condition in the log book together with the names of the crew and peruse any defects entered therein by the previous driver. If he considers the defect warrants such action, he should inform the Train Controller who will obtain instructions for him.

(b) As soon as possible when time permits, inspect the exterior of the locomotive and running gear for:

   (i) Liquid leaking from Loco.
   (ii) Loose or dragging parts.
   (iii) Proper positioning of angle cocks and shut off valves.
   (iv) Observe brake piston travels.
   (v) Drain main reservoirs.

(c) In the engine room:

   (i) Check for oil, water and fuel leaks.
   (ii) Check gauges and indicators for proper readings.
(d) In cab -

   (i) Check switches and levers in cab for correct position.

   (ii) Check contents of tool kit and suitably endorse the log book.

   (iii) Inspect the Vigilance Control.

   (iv) Check the Battery Charging Ammeter for proper operation.

The above instructions, with the exception of the tool kit check, the hand lamp and Vigilance Control do not apply to drivers when relieving just before the departure of a train, as in such a case it may be assumed that the previous driver has made these checks.

**Section 6. TRAIN EXAMINATION.**

When the Diesel Locomotive has been attached to a train and it is required to conduct the train examination, the following procedure will be adopted as a protection for the Train Examiner:

   (a) Place Independent Brake in slow application position.

   (b) Switch generator field circuit breaker at driver's control panel to OFF.

   (c) Remove reverser handle and place it in Train Examiner's box.

   (d) Train Examiner then places his key in the Train Examiner's box, locking the reverser handle in position.

   (e) When the train examination is complete, the Train Examiner will remove his key from the Train Examiner's box and release the reverser handle.
(f) Insert the reverser handle and place in desired direction of travel.

(g) Place dynamic brake handle to No. 1 position. (Does not apply to T & Y class).

(h) Switch generator field circuit breaker or switch at driver's control, panel to ON.

(i) Make equalising brake test.

(j) Drive off as described in Section 9 when "right away" is received from the Guard and signals are favourable.

Section 7. UNCOUPLING UNITS IN YARD.

This work must be carried out as set out below:

(1) The Driver of the leading unit shall secure both units by placing the Independent handle in the slow application position.

(2) On B class locomotives see that the Fuel Pump and Control circuit breakers are in the ON position on the Driver's panel, and on S, T and Y class locomotives, the Engine Run and Control are in the On position on both units.

(3) The Driver of the leading unit shall personally disconnect the jumper between units and see that it is secured in the loco. to which it belongs.

(4) The Fireman of the leading unit shall close the air pipe angle cocks and disconnect the hose pipes between units, securing them in the dummy couplings provided.

(5) The Driver of the leading unit shall put to ON the Generator Field circuit breaker or switch (T & Y class) on the Driver's panel instruct his Fireman to open the auto coupling and then separate the locos by a few feet.
If a crew is taking over the trailing unit, it will then be that Driver's responsibility to set up the controls correctly on the trailing unit.

If the trailing unit is to be left unattended it must be in clear of any crossovers with the hand brake hard on.

The Reverser must be placed in the Train Examiner's box, the Generator Field Circuit breaker or switch (T & Y class) in the OFF position, and the Isolation switch in the Start position.

Section 8. COUPLING UP UNITS.

When coupling up two units which are closed down, each unit must be started up separately. When the engines are running, the following procedure shall be carried out, and may be done by one driver and fireman.

1. Hold one unit stationary with the Independent Brake handle in the Slow application position, the reverser in the Train Examiner's box, and the Generator Field Circuit Breaker or switch in the OFF position.

2. Put the Generator Field Circuit Breaker to ON and driving from the leading end in the direction of this movement draw the second unit up to the stationary unit and couple to it.

3. The Driver, who is to drive the multiple unit, shall personally see that the auto couplers between the units are securely locked and on B and S Class Locos that the locking keys are inserted.

4. This Driver shall personally couple an electric jumper cable to a socket on each unit and see that it is firmly secured by the nibs on the covers.

NOTE. On S and B class locos in multiple, the jumper cable is connected straight across on one side.
On S and Y or T, B and Y or T or two T or Y class
lokos, in multiple, the Y or T class jumper cable is normally used
and connected diagonally from one side to the other. The S or B
jumper cable may be used and is connected straight across.

(5) The fireman shall couple up the No.3 control pipe
hoses and No.4 independent release pipe hoses, both
at either side of the loco. also the brake pipe hoses
and main reservoir hoses and make sure that all 8 angle
cocks are fully open.

(6) On the trailing unit the driver shall remove the brake
handles and put them in the glove box or top of the
clothes locker on T class locos. and see that both
brake valve isolating cocks are closed.

Put the reverser in the Train Examiner's box and put to
OFF, on B Class Locos., the Generator Field, Fuel Pump and
Control circuit breakers and on S, Y and T class locos, the
Generator Field, Engine Run and Control Circuit breakers or
switches (T & Y class).

See that the Isolotion switch is in the RUN position.

(7) At the driving end of the leading unit, put the brake
handles on, open the brake valve isolating cock and
see that it is closed at the non-driving end and insert
the reverser.

Put to ON, on B class locos, the Generator Field,
Fuel Pump and Control circuit breakers and on Y, T and S class
Locos the Generator Field, Engine Run and Control circuit
breakers or switches (T and Y Class).

(8) Put the Isolation switch to START on the leading unit.
Open the throttle and drive forward for a short distance
and stop with the Automatic Brake. (This tests the
jumper connection).
(9) Turn the Isolation switch to RUN on the leading unit and drive back a short distance and stop with the Independent brake. During this move, note that the Power Ammeter Needle rises and also see that the air brakes apply and release on both units.

(10) If the multiple unit cannot be moved (as when attached to a train) turn the Isolation switch to START on the leading unit, open and close the throttle quickly with the Generator Field in the ON position. Put the Generator Field circuit breaker to the OFF position, open the throttle to the 3rd notch and the driver should hear the engine of the trailing unit increase in speed. (This tests the jumper connection). Close the throttle to Idle, put the Isolation switch to Run and the Generator Field circuit breaker to the ON position.

(11) When one of the locos is attached to a train, the Train Driver shall take charge of the loco, to be attached immediately before it is attached and he shall be responsible for the coupling up which shall be carried out as above.

NOTE. Y class locomotives are not fitted with A.6.E.T. brake equipment and consequently when a Y class locomotive is coupled in Multiple with a B, T or S class locomotive the following brake arrangements must be made.

Y Class leading a B, T or S.

On the Y Class.

(1) Automatic Brake Valve in Running.

(2) Self Lapping Brake Valve in Running.

(3) Brake Valve Isolating Cock open.
On the B, T or S Class. (Trailing).

1. Automatic Brake Valve in Running on T class and also in Running at one end of a B or S Class loco.
2. Independent Brake Valve in Running on T class and also in Running at one end of a B or S class loco.

B, T or S Class Leading a Y Class.

On the B, T or S Class.

1. Automatic Brake Valve in Running at Driving end.
2. Independent Brake Valve in Running at the Driving end.
3. Brake Valve Isolating cock open at the Driving end and closed at the non-driving end.

On the Y Class.

1. Automatic Brake Valve in Release.
2. Self lapping Brake Valve in Running.

Section 9. OPERATION ON THE ROAD.

Starting.

(a) Assume train has just been examined as described in Section 6.
(b) On receiving "Right away" make equalising test.
(c) Release Independent brake.
(d) Take up any slack in train. On long trains this can be considerable.
(e) It is most important that the train is not allowed to roll back when starting and skilful use of the brake is essential, particularly on grades, to ensure that this does not occur. It will be found an advantage to advance the throttle as the brakes are releasing; this will prevent the train rolling back as the brakes are released.

(f) After the train is moving, the driver must, subject to restrictions of speed and track, endeavour to obtain maximum power as soon as possible as described below.

On the Journey.

Maximum power is achieved by "notching UP" on the throttle lever, the ammeter being used as a guide in the following manner:

On goods trains as soon as the ammeter gauge pointer steadies, the throttle must be immediately moved to the next notch.

The needle will fall slightly and then rise again until it again comes to rest when the throttle must immediately be advanced another notch. This is repeated until the throttle is in No.8 position, the engine speed then being at a maximum, and the load will be automatically regulated by the Load Regulator.

To achieve best results, drivers must not pause unnecessarily long between notches.

It is emphasised that maximum power is only obtainable in No.8 throttle position and drivers must have that position as their objective whenever starting away from a station or approaching a grade.

When notching up with train travelling at speed, after rolling and the slack is taken up, or after starting a passenger train, the driver may notch up with only a slight pause between each notch and without reference to the ammeter.
It must be remembered that S and some T class locos, make forward transition in the 7th or 8th notch so that if the maximum acceleration is required the throttle must be moved to the 8th notch.

Over undulating country the train speed can be controlled by means of the throttle, notching down with the same pause as notching up.

**Lifting Train on Steep Gradients.**

Owing to their high starting tractive effort, Diesel Electric locomotives will lift their present schedule loads on any ruling grade from a standing start if properly handled. The method to be observed is as follows:

Make sure sanders are operating. Advance the throttle normally to the 3rd notch, at the same time releasing the brakes and applying sand to the rails. The train should now move, but if not, advance the throttle to No.4, then No.5, but not beyond No.5. At No.5 notch the ammeter will show a reading in excess of 1000 amps (B class) and if the train does not move in this position, make a heavy automatic brake application and move the throttle notch by notch back to Idle otherwise the high amperage sustained beyond one minute will damage the motors.

Repeat the above making sure that a good release of the brakes is obtained. The train will move providing the brakes are properly released.

When the train is moving, sand the rails continuously and do not advance the throttle until momentum is gained, and the ammeter reading has dropped and remains steady.

In cases where the state of the rails is bad, note the reading on the ammeter where the locomotive slips, and by throttle adjustment do not let the ammeter build up to this point. Remember that if the throttle is manually reduced one notch it is better than allowing the loco, to slip which automatically reduces the engine speed 2 notches on B class Locos.
Slipping.

If the rail is slippery, the driver should use sand when notching up to increase adhesion and PREVENT slipping.

Engine revolutions (B class) and power drop back as soon as the engine slips, so endeavour to prevent slipping by anticipation in the use of sand. If the locomotive slips the red light on the driver's control panel will flash and the driver must reduce throttle until it stops and then apply sand and notch up again. If the locomotive continues to slip when throttle is again notched up the throttle should be returned to a suitable position where slipping is prevented.

NOTE. On Multiple unit locos when the trailing unit slips a red wheel-slip light will appear on the driver's panel of the leading unit.

Dynamic Braking. (Does not apply to T and Y Class).

The Dynamic Brake can be used on both passenger and goods train.

Should the Brake Warning lights show up the Dynamic Brake must be reduced until the light disappears.

The throttle must be in the "Idle" position and the reverser handle in the direction of movement before the dynamic brake can be used. After placing the throttle to "Idle" at least 3 seconds should be allowed before applying the dynamic brake in order to allow the generator field to die and the diesel engine to return to Idling Speed. On S class Locos no delay in operating the controls is necessary as there is an automatic time delay in the movement of the brake transfer switches.

When using the dynamic brake, the ammeter must be closely observed, as this indicates a measure of the braking power being used. The reading on the ammeter must not be allowed to exceed 600 amps, or 700 amps on S class locos. If it does, the red light on the driver's control panel will flash and when this occurs,
the driver must ease off the dynamic brake and apply the air brake if necessary to control the train speed.

At times the red light will flash when the dynamic brake is being used and the braking power is less than 600 amps. This indicates wheel skid, and in such a case the brake should be eased and sand applied to the rails.

Wheel skid when dynamic braking, however is more definitely indicated by the speed indicator which will drop to zero. This may not necessarily be accompanied by a red warning light especially when all wheels skid together. Under these circumstances, the dynamic brake should be eased off as before and sand applied to the rails to increase adhesion.

Coasting.

When coasting within a section and the driver considers that the use of the dynamic brake is unnecessary, the throttle lever may be left in the No.1 position. When bringing a train to a stand, however, the throttle must be moved to the Idle position. It must also be moved to Idle when the speed of the train is so low that the Loco. will make backward transition when the throttle is again opened to increase power (on B class this occurs at 25 MPH and on T & S class 10 MPH).

When coasting and it is anticipated that the use of the dynamic brake will be necessary, the throttle must be moved to the Idle position.

Stopping.

For a normal stop, move throttle to Idle pausing between each notch, and then apply the air brake in the normal manner. The throttle must not be swept through notches direct to Idle position unless in case of emergency.
In emergency, such as fire, impending collision, etc., in addition to stopping the train with the air brake the diesel engine may be stopped by placing the throttle to Idle, pressing in the button on the end of the throttle lever and pushing the throttle lever to the "stop" position. Then switch the fuel pump circuit breaker on driver's control panel "OFF".

The dynamic brake where fitted may be used in conjunction with the air brake to stop a train, but only when a "two application" stop is made and in the following manner:

(a) Apply the dynamic brake early before the 1st air application.

(b) Apply the automatic air brake.

(c) Release the automatic air brake when speed has dropped sufficiently.

(d) Release the dynamic brake.

(e) Make a light automatic air brake application to stop the train, releasing just before coming to a stand to ensure a smooth stop.

When making a 'one application' stop, the dynamic brake should not be used, but the locomotive brakes should be graduated down to 10 lbs. with the independent brake handle when the train is well under control. The brakes should then be released just prior to coming to a stand with 7 car train or less, or held on if train consists of over 7 vehicles.

When stopped for any length of time, such as meal intervals, waiting line clear etc., the reversing handle should be placed to "Neutral" and the generator field circuit breaker on the driver's panel should be switched "OFF".
Reversing.

If it becomes necessary to reverse direction of travel it is most essential that the train be brought to a stand before placing the reversing handle to the reverse position, therefore, adopt the following procedure.

(a) Throttle to Idle, pausing between each notch.
(b) Apply the air brakes and bring train to stand.
(c) Place reversing handle to reverse position.
(d) Release brakes and open throttle, taking care again that the loco does not roll in a counter direction before throttle is opened.

Shunting.

Drivers must endeavour to prevent continued opening and closing of throttle when shunting and try to judge speed to prevent this happening.

Section 10. AUTOMATIC STAFF EXCHANGER OPERATION.

B AND S CLASS LOCOMOTIVES.

(a) Lift cab floor flap and secure.
(b) Raise exchanger by means of three way air control valve.
(c) Place air control valve in neutral position and throw over locking bar.
(d) Place staff in exchanger making sure pouch is well in and ring secured by clip.
(e) Ease exchanger down ramp by hand then use air control valve to ensure that it reaches full travel.
(f) Place air control valve in neutral position when exchanger is down but on S class leave the valve control lever in the down position.

(g) After exchanging staff, raise the exchanger by means of the air control valve.

(h) Remove staff and place air control valve in neutral.

(i) Throw locking bar over and ease exchanger down on to it by hand.

(j) Close cab floor flap.

Section 11. **SPEED RECORDER**

'B' class diesel electric locomotives are each fitted with a speed indicator and recorder at the No. 1 end, and a speed indicator only at No. 2 end.

Every driver prior to commencing a journey or when relieving another driver shall write on the speed recorder chart of the locomotive he is driver as under:

(a) The date.

(b) Scheduled time of departure of train from station at which chart is signed.

(c) Station from and to:

(d) Class of train, P, M, G, L E, Bona, Ballast;

(e) Driver's name;

(f) Number of locomotive and end from which it is driven when on the train;

(g) Number of assisting locomotive;

If brought to a stand in section for any reason other than the aspect of fixed signal, briefly write the reason.
On Y, T, S and B class locos fitted with Hasler Recorders the following procedure will also be carried out.

Drivers will be required when signing and winding the recorder to also set the clock to the correct time.

The figures showing on the clock face are 1 to 12 in white and 13 to 23 in blue. The figures 13 to 23 are to be considered as the p.m. hours.

On clock face under the figures 12 there is a round dot which is either white or blue, white indicating a.m., and blue the p.m. hours.

To Set the Clock.

(1) Observe the colour of the dot. This must be made to show white during a.m. hours and blue during p.m. hours.

(2) If the colour showing is correct pull out the right hand key and turn it either clockwise or anti-clockwise until the hands shown the right time.

When the hand of the clock are being moved in the anti-clockwise direction it is necessary to move them to a position at least 10 minutes earlier than the correct time and then in a clockwise direction to the correct time. Then push the key to its original position.

(3) If the colour showing is wrong for example, blue at 10.0am pull out and turn the key until the correct time is showing and if necessary a further 12 hours till the dot is the right colour, for example, white at 10.0am.

To Wind the Clock.

After the hands have been set the clock should be wound by pulling out the left hand key and turning it anti-clockwise till tight and pushing it back. In no circumstances must the front of the case be opened while the loco is in motion.
All speed recorders are fitted with the moveable panel on the right hand side and there is no need for Drivers to open the case at all.

Section 12. FAILURE OF A SINGLE UNIT LOCO.

(a) Secure the train and protect under regulations.

(b) Endeavour to locate and repair defect. Water must not be put into the engine cooling system without the approval of the Sup't. of Loco. Maintenance or his Deputy.

(c) Do not spend excessive time on above, but if unable to remedy defect Driver to write note setting out defect, possible cause or symptoms and give to Fireman to have relayed through Control to the senior Branch Officers who will advise action to be taken.

For Towing.

(d) The reverser handle must be removed and placed in the Train Examiner's box.

(e) Both Brake Valve handles must be in Running position and the brake isolating cocks closed.

(f) The dead engine cock on the distributing valve to be open.

(g) On T class locos the reversing switch should be centred in the neutral position by manually operating the button on top of the switch. The locking pin normally carried on the left side of the reverser should be inserted from the right side and screwed home to lock the reverser.

NOTE. On T.357 and above the Reversing Switch is not manually centred, but the Local Control Circuit Breaker must be put to the "OFF" Position.

On Y class locomotives being towed the Local Control Circuit Breaker must be put to the "OFF" Position.
Section may be cleared at normal speed, defect permitting. On arrival at station ahead driver should then confer through control with senior Branch Officers for advice.

NOTE. If towed by a B, T or S class diesel electric with the Air Hoses all coupled between the locos, these clauses (e) and (f) do not apply. The Brake Valve Isolating Cock must be closed, the Independent Brake handle in lap and the Automatic in the running position.

Towing a Dead Y Class Locomotive.

(a) Couple the Brake Pipe between the locomotives and open the brake pipe cocks.

(b) Remove the Reverser.

(c) Put the Automatic Brake handle in the Release position and the Self Lapping Brake Valve in the Running position.

(d) Close the Brake Valve Isolating cock.

(e) Put the Local Control Circuit breaker on the Isolation Switch panel to the "OFF" Position.

When a Y class locomotive is hauling a dead B, T or S class locomotive the brake arrangements on the dead loco. are as follows:

(a) Put the Automatic Brake handle and the Independent Brake handle in the Running position.

(b) Close the Brake Valve Isolating cock or cocks.

(c) Open the Dead Engine cock on the Distributing Valve.
Section 13. FAILURE OF ONE UNIT IN MULTIPLE.

(i) Failure of Rear Unit.

(a) & (b) As for failure of one unit above.

(c) Shut down defective unit if not already shut down. This is done in the normal way.

NOTE. The clearing of a section is of primary importance and if one locomotive can haul the train to the next station or siding the above sections of this instruction shall be deferred until the safety of the station or siding ahead is reached.

(d) The section may then be cleared with the one effective unit, dividing the train if necessary.

(e) The train may be run at normal speed, defect permitting, to the next station and the driver will contact senior Branch Officers through Control for advice.

(f) If the defective unit is to be left in a siding it must be left with the hand brake on, windows closed and doors locked.

(g) The keys and report of failure to be given to the Station Master of station where unit is left.

(ii) Failure of Front Unit. (But controls of leading unit still operating rear unit).

(a) & (b). As for previous.

(c) Shut down defective unit if not already stopped or turn the Isolation Switch to START, but leave circuit breakers on driver's panel at the ON position.
(d) Clear section at normal speed defect permitting, dividing train if necessary, and driving from the front end of the defective unit.

(e) Upon arrival at station ahead, contact senior Branch Officers through Control for advice.

(f) Return for second half of train if divided, and depending on the load and gradient the driver will have to decide whether he will take the whole train forward or leave part in the siding.

(iii) Failure of Front Unit. (Electrical fault and controls in-operative).

(a) Secure train and protect under regulations.

(b) Endeavour to locate and repair defect.

(c) Do not spend too much time on the above but clear the section as soon as possible.

(d) If defect cannot be rectified, put Isolation Switch to START, centre the Reverser or put Local Control to OFF.

(e) Place Generator Field circuit breaker on driver's panel to OFF.

(f) Remove reverser handle, and place in Train Examiner's Box.

(g) Remove jumper cable between units.

(h) At the leading end of the trailing unit, place Generator Field, Fuel Pump and Control circuit breakers on Driver's control panel to the ON position.

(i) The Driver will ride in the leading end of the defective unit and will be responsible for the observance of signals and the braking of the train. The Fireman will apply power from the leading end of the trailing unit under instructions from the Driver.
The section shall be cleared at low speed and upon arrival at the station ahead the Driver must contact senior Branch Officers through Control for advice.

**NOTE.** If the failure of a diesel unit of either single or multiple locomotive is found to be due to a locked traction motor, after the observance of a continuous red light showing on the driver's panel wheel slip light, the loco, must not be moved until expert advice is obtained.

It is important to note that if the diesel engine of the locomotive stops, so too does the air compressor, and precautions should be taken to hold the train by dropping sufficient handbrakes along the train in such a situation.

Section 14. **COUPLING STEAM ENGINES TO DIESEL LOCOS.**

If it becomes necessary to send a steam locomotive to the relief of a disabled diesel electric locomotive, the following facts must be borne in mind.

(a) All steam loco. tenders having automatic couplers can be coupled to main line diesel electric locomotives.

(b) Steam locos. fitted with the plate type cowcatchers can be coupled at their front ends to the diesel electric locomotives.

(c) Steam locomotives with bar type cowcatchers can not be coupled at their front ends to the main line diesel electric locomotives, and if it is not expedient to turn such locos. sent out as relief, then an auto. coupled truck must be pushed out to enable the coupling up to be facilitated.
Section 15. STARTING UP THE DIESEL ELECTRIC LOCOS.

When it is necessary for a crew to start up a locomotive which, through some abnormal train running delay, has been shut down in excess of two hours, the following sequence of operations is to be observed:

B Class.

(1) In the Electric cabinet.
   (a) Close the Battery Switch.
   (b) See that the lights, control and auxiliary generator switches are closed.
   (c) See that the 5 circuit breakers in the electrical cabinet are in the "ON" position.

(2) See that the hand brake is ON.

(3) Place the brake handles in position with Independent handle in the "slow application" position and the Automatic handle in the "Running" position and see that the Brake valve isolating cock is open at the driving end and closed at the non-driving end.

(4) Put the reverser in the Train Examiner's box at the driving end.

(5) On the Driver's panel put to ON the control circuit breaker.

(6) See that all test cocks are open 3 full turns.

(7) With the Isolation switch in the "START" position hold out the Lay Shaft and press in the start button for a short time and release, observe if any liquid has discharged from the test valves. If no discharge liquid, the engine may be started as set out below.
If there is a discharge, the engine should not be started until maintenance staff has been informed.

8. Put the Fuel Pump circuit breaker on the driver's panel to the ON position.

9. Close the test cocks with the test cock key, be sure that they are nipped home securely.

10. While closing the valves see that,
   (a) the Low Oil button is not out,
   (b) the Overspeed Trip lever is set normal,
   (c) the fuel return glass is full of clear fuel.

11. Press in the Start button and hold the Loyo Shaft in until the engine starts.

12. If the bell rings when the Start button is pressed this may be due to the tripping of the Ground Relay but the Driver should continue to press it in, until the engine starts and then reset the Ground Relay.

13. Turn the Isolation switch to RUN.

14. Examine the engine water level and if there is any water showing in the glass with the engine running the loco. can run its train. If the water is out of the glass with the engine running inform Control.

15. Release the Hand Brake.

16. At the Driving end put to ON the Generator Field circuit breaker.

17. Put the Reverser Lever to "Forward" or "Reverse"

18. Open and close the throttle and while it is open see that the needle rises on the ammeter on the Driver's panel. If no power is obtained, the starting contactors may have to be wedged open.
Y and T Class.

1. In the Electrical cabinet.
   a. Close the Battery Switch.
   b. See that the lights, Control and Auxiliary Generator switches are closed. (320-356)

2. See that the hand brake is ON.

3. Place the Brake handles on, with the Independent handle or Self Lapping Brake Valve in the "slow application" position and the Automatic handle in the "Running" position and see that the Brake Valve Isolating cock is open.

4. On the Isolation switch panel put the Fuel pump circuit breaker to the OFF position and see that all other circuit breakers on this panel are in the ON position.

5. On the Driver's Panel put to ON the Control and Engine Run switches.

6. See that all test cocks are open 3 full turns.

7. With the Isolation switch in the START position press in the Start button for a short time and release. Observe if any liquid has discharged from the test valves. If no discharge of liquid the engine may be started as set out below but if there is a discharge of liquid the engine should not be started until the maintenance staff has been informed.

8. Put the Fuel Pump circuit breaker on the Isolation switch panel to the ON position.

9. Close the test valves with the test cock key, be sure they are nipped home securely.
While closing the valves see that the,

(a) Low Oil button is not out,
(b) Overspeed Trip lever is set normal,
(c) fuel return glass is full of clear fuel.

Press in the start button until the engine starts.

Turn the Isolation switch to "RUN".

If the bell rings and the Red Ground Relay light shows up then press in on the button and reset the Ground Relay.

Examine the engine water level and if there is any water showing in the glass with the engine running, the loco. can run its train, but if the water is out of the glass with the engine running, inform Control.

Release the hand brake.

On the Driver's panel put to ON the Generator Field switch.

Put the Reverser Lever to forward or reverse.

Open and close the throttle quickly and while it is open, see that the needle rises on the Ammeter on the Driver's panel.

In the Electric cabinet.

(a) Close the Battery switch.
(b) See that the Lights, Control, and Auxiliary Generator switches are closed.
(c) Put the Fuel Pump circuit breaker to the OFF position.
(d) See that the other 4 circuit breakers are in the ON position.

(2) See that the hand brake is ON.

(3) Place the Brake handles on at the driving end with the Independant handle in the "slow application" position and the Automatic handle in the "running" position and open the brake valve Isolating cock at that end and see that it is closed at the non-driving end.

(4) Put the reverser in the Train Examiner's box at the driving end.

(5) Put to ON the Control and Engine Run circuit breakers on the Driver's panel.

(6) See that all test cocks are open 3 full turns.

(7) With the Isolation switch in the START position hold the Lay-shaft out and press in the Start button for a short time and release, observe if any liquid has discharged from the test valves. If no discharge of liquid the engine may be started as set out below but if there is a discharge the engine should not be started until the maintenance staff has been informed.

(8) Put to ON the Fuel Pump circuit breaker in the electrical cabinet.

(9) Close the test valves with the test cock key, be sure they are nipped home securely.

(10) While closing the valves see that the

(a) Low Oil button is not out,
(b) Over speed Trip lever is set normal,
(c) the fuel return glass is full of clear fuel.

(11) Press the Start button in and hold the Lay Shaft in, until the engine starts.
(12) Turn the Isolation switch to RUN.

(13) If the bell rings and the Red Ground Relay light shows up, then press in on the Ground Relay reset button, on the Driver's Panel or in the Electrical cabinet and reset the Relay.

(14) Examine the engine water level and if there is any water showing in the glass with the engine running, the loco. can run its train but if the water is out of the glass with the engine running inform Control.

(15) Release the hand brake.

(16) On the Driver's Panel put to ON the Generator Field Circuit Breaker.

(17) Put the Reverser Lever to "Forward" or "Reverse".

(18) Open and close the throttle quickly and while it is open see that the needle rises on the Ammeter on the Driver's Panel.

After Starting (B, S, Y and T Class Locos).

Check the battery charging ammeter in electrical cabinet to see that it indicates a charge. If not auxiliary generator switch in electrical cabinet may be open or 150 amp. or 30 amp. fuse blown.

When it is necessary for a crew to start up a locomotive which, through some abnormal train running has been shut down for a period not exceeding two hours, the above procedure is to be adopted with the exception that it will not be necessary to open the test cocks and test for discharge of liquid from the cylinders.

When it is necessary to restart a locomotive after it has merely been taken "off line" and stopped for a short while to make some adjustment or for any other reason, it may be restarted in the following manner:-
(i) See that Isolation switch is in "START" position.

(ii) Press the Start button and push the hand throttle inwards on "B" and "S" until engine fires - not more than 15 seconds.

(iii) Put the Isolation Switch to the "Run" position.

(iv) See that 60-90 lbs. of air is available to operate the Electro pneumatic controls. (Not necessary Y class or T. 357 onwards).

Section 16. PLACING ENGINE "ON", AND TAKING ENGINE "OFF" LINE.

The method of placing the engine on "Line" or taking engine off "Line" is fully described in the Operating Manual for the Diesel Electric Locomotive ML.2, on pages 24, 25 and 26, and no further details are required in these instructions.

Section 17. AIR BRAKE.

B, T and S Class.

Each unit is fitted at both ends with an A7-EL pedestal type brake embodying automatic and independent operation similar to the A6-ET brake on steam locomotives. Since they have been placed in operation on the Victorian Railways, each unit has been fitted with an independent brake pipe connection for multiple unit operation by means of which the control of the independent brake on both units is vested in the driver. Drivers are reminded that the duplex gauge on the driver's control panel indicating brake cylinder pressures FRONT and REAR bogies of each particular unit, and not FRONT and REAR units when in multiple operation.

Y Class.

These locos are equipped with the No. 4 Automatic Brake Valve and the self Lapping Brake Valve so that particular
care must be taken when coupling them to B, T or S class locos.

Section 18. GENERAL.

With the exception of the Melbourne Yard and South Dynon Depot, Diesel-Electric Locomotives must not proceed from a traffic yard to a locomotive depot unless specially authorised.

When bringing a Diesel-Electric Locomotive to a stand, the Driver must regulate such stop to ensure that the loco. is clear of any ashpit or other location where hot ashes have been discharged on to the permanent way. The ashpit road must not be used by a Diesel Electric Loco. during any movement at a Depot unless the Driver is instructed to do so by the Officer-in-Charge.

When running through water after heavy rain, washaways etc., and the water is high enough to reach the wheel flanges, the speed should not exceed 3 m.p.h. If water level is above rail level, the loco. must not proceed unless advice is received from the Chief Mechanical Engineer's Office.

If the red wheel slip-light on the Driver's control panel should continue to glow after throttle has been reduced and sand has been applied, stop the train and investigate for possible locked wheels.

If found locked, the loco. must not be moved until expert advice has been received.

On T Class Locos. the Red Wheel slip light showing on the Driver's panel when the throttle is closed may be caused by a defective Wheel Slip Relay in the Electrical Cabinet at the Front End of the Locomotive.

Section 19. TROUBLE SHOOTING.

A comprehensive range of troubles, their probable causes and remedies will be found in the Operating Manuals, which have been issued to every employee qualified to drive the diesel electric locomotives.
Assistance will also be obtained from the following lists of "Questions and Answers" for the various types of locomotives.

It is the duty of the Driver to enter all defects and irregularities in the Log Book.
QUESTIONS AND ANSWERS FOR
B CLASS DIESEL LOCOMOTIVES.

1. WHAT WOULD YOU DO IF YOU OPENED THE THROTTLE ON A B CLASS LOCO. AND GOT NO POWER ALTHOUGH THE ENGINE SPEED INCREASED?

(a) If power has not been obtained since the engine was started up, then examine and if necessary prise open the starting contactors.

(b) Test and reset the Generator Field Circuit Breaker on the Drivers panel. If it will not reset change ends and drive the loco in reverse until an opportunity occurs to turn it.

(c) See that the reverser lever is in the correct position.

(d) See that the control air pressure is sufficient to operate the pneumatic controls. If control air pressure is too low, locate cause and report to Train Control.

(e) Renew the Battery Field (80 amp) fuse with a tested fuse.

(f) Examine the Dynamic Brake (DB) contactors and see that they are open when the Dynamic Brake Lever is in No.1 position. Prise open, if not possible advise Train Control.

(g) Examine the Battery Field (BF) contactor which should close when the throttle is opened. If not closed advise Train Control.

(h) Put the reverser to neutral and examine the power contactors. The 9 contactors should be open. If not, prise open with the wooden wedge.
(i) Examine the reverser drums. If not in the correct position move them by operating the magnet valves or with the wooden wedge.

(j) Put the Dynamic Brake lever in No. 1 position, open and close the throttle quickly and examine the cam switches. The top left hand contactor should be open. If not in this position, put throttle to idle, and operate the magnet valve by hand.

2. WHAT IS THE PURPOSE OF THE BATTERY CHARGING AMMETER?

To indicate to the driver whether the battery is or is not being charged when the engine is running.

3. WHAT WOULD THE DRIVER DO IF HE OBSERVED A DISCHARGE ON THE BATTERY CHARGING AMMETER WHEN THE ENGINE IS RUNNING?

(a) Renew the Auxiliary Generator (Aux. Gen.) fuse (150 Amp) with a tested fuse (Blue light and bell).

(b) Examine the reverse current relay (R.C.R.) and see that the INNER contacts are touching. If not, report to Train Control.

(c) Examine the Battery Charging (B.C) contactor which should be closed. If not closed, report to Train Control.

(d) Examine the Auxiliary Generator (Aux. Gen.) knife switch which should be closed.

(e) Examine and reset the Auxiliary Generator (Aux. Gen.) Field circuit breaker.

NOTE. When the battery is discharging the power reduces and the lights become dimmer.
Drivers must understand that whenever a B class Loco. Shuts Down "On Line" the Blue Light shows and the Bell rings automatically.

4. WHAT WOULD YOU DO IF THE ENGINE STOPS?
   (a) Examine the throttle and see that it is not at STOP.
   (b) Test and reset the Fuel Pump circuit breaker on the drivers panel. If it cannot be reset use the Fuel pump circuit breaker at the non driving end.
   (c) Examine and reset the Ground Relay (G.R.)
   (d) Test and reset the Fuel Pump circuit breaker in the electrical cabinet.
   (e) Examine and reset the Alternating Field (ALT.FLD.) circuit breaker.
   (f) Examine and reset the Auxiliary Generator (AUX.GEN.) field circuit breaker.
   (g) Examine the No Volt relay. (N.V.R.) If open, when engine restarted check cooling air blowing through traction motors and report to Train Control.
   (h) Examine and close the Control knife switch.
   (i) Examine and report if the Engine Relay contacts are open.
   (j) Examine and report if the contacts of the Fuel Pump Contactor (F.P.C.) are open.
   (k) Examine and if necessary reset the Overspeed Trip Lever.

NOTE. This may be due to seized injectors which can be detected by trying to move the layshaft.
(l) Examine the governor and see if the low oil pressure button is tripped. If tripped press in and start engine (Do not push in too far).

(m) Examine the fuel by-pass and the fuel return glass. The one nearest the engine should be full of fuel, the other one empty.

(n) Examine the governor oil level. If no oil in glass get permission to put oil in the governor.

(o) Determine the amount of fuel in the tank.

(p) Examine the fuel pump and jumper cable connections also fuel pipes.

5. WHAT WOULD YOU DO IF YOU OPENED THE THROTTLE BUT THE ENGINE DID NOT SPEED UP AND THE LOCO. MOVED VERY SLOWLY OR NOT AT ALL?

(a) Examine and reset the Control circuit breaker on Drivers panel if it will not reset, use the Control circuit breaker at the non driving end.

(b) Examine and reset the Ground Relay. (G.R.)

(c) Examine and reset the Alternating Field Circuit Breaker (ALT.FLD.)

(d) Examine and reset the Auxiliary Generator (AUX. GEN.) circuit breaker.

(e) Examine No-Volt Relay. If open check cooling air at the traction motors and report to Train Control.

(f) Examine and close the Control knife switch (Note engine will shut down in a few minutes if open).

(g) Examine the Engine Relay (ER). If open report to Train Control.

(h) Examine and put Isolation switch to RUN.
6. WHAT WOULD YOU DO IF THE HEADLIGHT FAILED?
   (a) Examine and reset the headlight circuit breaker on the driver's panel. If defective use the rear headlight circuit breaker at the non driving end.
   (b) If still no light take the globe out of the rear end and use it in front.

   NOTE. Some B Locos are fitted with sealed beam headlight and consequently cannot be changed.

7. WHAT WOULD YOU DO IF ONE UNIT OF A MULTIPLE UNIT LOCO. FAILED?
   (a) Bearing in mind that the section must be cleared as soon as possible make a quick inspection to locate and if possible rectify the fault.
   (b) If unable to quickly locate the fault, use the good unit to haul the train.
   (c) Inform Control of the failure at the first staff station, and then if possible immediately continue on with the train until instructed otherwise.

     On B and 5 class locos there is no need to lock the reversers in the neutral position when being towed.

8. WHAT WOULD YOU DO IF THE ALARM BELL RANG AND THE HOT ENGINE LIGHT SHOWED ON A B CLASS LOCOMOTIVE?
   (a) Keep the train moving and clear the section.
   (b) On arrival at the staff station inspect the loco. to find the cause of the hot engine.
   (c) If the bell is still ringing or the water is out of the glass when the engine is running report to Train Control.

   NOTE. B Class locos can run so long as there is any water showing in the glass when the engine is running.
QUESTIONS AND ANSWERS FOR
S CLASS DIESEL ELECTRIC LOCOMOTIVES.

1. WHAT WOULD YOU DO IF YOU OPENED THE THROTTLE
   AND DID NOT OBTAIN POWER ALTHOUGH ENGINE
   SPEED INCREASED?

(a) Check that the Generator Field circuit breaker on the
    Driver's panel is in the ON position. If the circuit
    breaker will not reset unlock the switches at Hostler's
    Control end and push in the Generator Field switch,
    but continue to drive from the Main Control end.

(b) See that the Reverser lever is in the correct position.

(c) See that the Selector lever is in the 1 position.

(d) See that control air is sufficient to operate the
    pneumatic controls. If control air is too low locate
    cause and report to Train Control.

(e) Renew the 80 amp Battery Field fuse.

(f) S.310 and onwards. Examine Shunt Field and Battery
    Field contactors. When the throttle is opened to No.1
    notch the 3 dots seen in the porthole are seen to be V
    shaped. If not inform Train Control.

(g) Put the Reverser lever to neutral and examine the 5
    power contactors which should all be open. If not
    open, prise open with a wooden wedge.

(h) Examine the Reverser drum. If not in the correct
    position move it there by hand operation of the magnet
    valve or with the wooden wedge.

(i) With the Selector lever in 1, Reverser in Forward,
    Generator Field circuit breaker ON, open and close
    the throttle quickly and then examine the Brake
    Transfer (Cam) switches. The top left hand contactor
    should be open. If not operate the Left Hand magnet
valve (MOT) by hand.

(j) With the throttle closed examine the Field Shunting Contactors F.S.1 and F.S.2 at the right back of the electrical cabinet and see that they are open. If all the contacts are not open, use the wooden wedge to prise them apart and report the fault in the log book.

2. WHAT IS THE PURPOSE OF THE BATTERY CHARGING AMMETER?

To indicate to the Driver whether or not the battery is or is not being charged while the engine is running.

3. WHAT WOULD YOU DO IF YOU OBSERVED A DISCHARGE ON THE BATTERY CHARGING AMMETER WHEN THE ENGINE IS RUNNING?

(a) Renew the 150 amp Auxiliary Generator (AUX. GEN.) fuse with a tested fuse.

(b) Examine and reset the Auxiliary Generator (AUX. GEN.) Field circuit breaker.

(c) Examine the Auxiliary Generator Knife Switch which should be closed.

(d) On S.310 onwards Examine the Battery Charging contactor. The 3 yellow dots seen in the porthole should be V shaped. If the dots are in line inform Train Control.

NOTE. If the 150 amp fuse is defective or the Auxiliary Generator circuit breaker trips, the alarm bell will ring and the blue light will show on the engine room panel.

4. WHAT WOULD YOU DO IF THE ENGINE STOPS?

(a) Examine the throttle to see that it is not at STOP.
(b) Check the Engine Run circuit breaker on the Drivers panel is in the ON position. If it cannot be reset, unlock the switches at the Hostler control end and push in the Engine Run switch.

(c) Check the Control circuit breaker on the Driver's panel is in the ON position. If it cannot be reset unlock the switches at the Hostler Control end and push in the Control switch.

(d) If the Ground Relay light is showing, put the throttle to idle, and push in the Ground Relay reset button, if the bell does not stop press in the manual reset button (using the point of a pencil if necessary) on the Ground Relay in the electrical cabinet. Later S class locos have the same Ground Relay as B, T and Y class locos.

(e) Examine and close the Control Knife switch.

(f) Examine and reset the Fuel Pump circuit breaker in the electrical cabinet.

(g) Examine and reset the Auxiliary Generator Field circuit breaker in the electrical cabinet.

(h) Examine and reset the Alternator Field circuit breaker in the electrical cabinet.

(i) Examine the No Volt Relay. If open after the engine has been started, check for cooling air blowing through the REAR traction motors and report to Train Control.

(j) Examine the Engine Relay. On S.300 - S.309 the relay may be heard operating by putting to ON and OFF the Engine Run circuit breaker. On S.310 onwards the 3 yellow dots should be V shaped. If defective advise Train Control.
(k) Examine the Fuel Pump contactor on S.300 - S.309. The contactor may be heard operating by putting ON and OFF the Control and Fuel Pump circuit breaker with the reverser lever in neutral. On S.310 onwards the 3 yellow dots should be V shaped. If defective advise Train Control.

(l) Examine and if necessary reset the Overspeed trip lever.

**NOTE.** This may be due to seized injectors which may be detected by trying to move the layshaft.

(m) Examine the governor and see if the Low Oil pressure button is out. If tripped press in the button and start the engine (Do not press in too far).

(n) Examine the governor oil level. If no oil advise Train Control.

(o) Examine the fuel by-pass glass and the fuel return glass. The one nearest the engine should be full of clear fuel, the other empty.

(p) Examine the fuel pump and connections also fuel pipes for leaks.

(q) Determine the amount of fuel in the tank.

5. **WHAT WOULD YOU DO IF YOU OPENED THE THROTTLE AND YOU DID NOT OBTAIN INCREASE IN REV'S AND THE LOCO MOVED VERY SLOWLY OR NOT AT ALL?**

(a) Examine and reset the Control and Fuel Pump circuit breaker on the Driver's panel. If it cannot reset unlock the switches at the Hostler Control end and push in the Control and Fuel Pump switch. (Engine will shut down in a few minutes).
(b) Examine and reset the Engine Run circuit breaker on the Driver's panel. If it cannot reset unlock the switches at the Hostler Control end and push in the Engine Run switch.

(c) Examine and put the Hostler Control Switch to the correct position.

(d) Examine and reset the Alternator Field circuit breaker.

(e) Examine and reset the Auxiliary Generator Field circuit breakers.

(f) Examine the Engine Relay. On S.300 - S.309 the relay may be heard operating by putting to ON and OFF the Engine Run circuit breaker. On S.310 onwards the 3 yellow dots should be V shaped. If defective advise Train Control.

(g) Examine the No Volt Relay which should be closed. Check if cooling air is blowing through REAR traction motors. If defective advise Train Control.

(h) Examine and reset the Ground Relay.

(i) Examine and put the Isolation Switch to Run.

6. WHAT WOULD YOU DO IF ONE UNIT OF A MULTIPLE UNIT FAILED?

(a) Bearing in mind that the section must be cleared as soon as possible make a quick inspection to locate and if possible rectify the fault.

(b) If unable to quickly locate the fault, use the good unit to haul the train.

(c) Inform Control of the failure at the first staff station and then if possible immediately continue on with the Train until instructed otherwise. On S class locomotives there is no need to lock the reverser in neutral.
7. WHAT WOULD YOU DO IF THE ALARM BELL RANG AND THE HOT ENGINE LIGHT SHOWED?

(a) Keep the train moving and clear the section.

(b) On arrival at the staff station inspect the locomotive to find the cause of the Hot engine.

(c) If the bell is still ringing or the water is out of the glass when the engine is running inform Train Control and act under instructions.

NOTE. S Class locomotives may run so long as there is any water showing in the glass when the engine is running.
QUESTIONS AND ANSWERS FOR
T CLASS DIESEL LOCOMOTIVES T.320 - T.356.

1. WHAT WOULD YOU DO IF YOU OPENED THE THROTTLE ON A T CLASS LOCO. AND GOT NO POWER TO MOVE THE TRAIN ALTHOUGH THE ENGINE SPEED INCREASED?

(a) If power has not been obtained by the Driver who started up the engine, and no other fault was found, shut the engine down and restart, and if still no power advise Train Control.

(b) Check Generator Field Switch on the Drivers panel and if defective advise Train Control.

(c) See that the reverser is in the correct position.

(d) See that Control air is sufficient if not advise Train Control.

(e) Check and test Battery Field 80 amp fuse.

(f) Examine Shunt Field contactor which should close when the throttle is put to No.1 position. On T.347 - T.356 Battery Field contactor can also be seen operating.

(g) Put reverser to neutral and examine the 3 power contactors which should all be open, if not able to prise open advise Train Control.

(h) Examine the reverser drum. If not in the correct position, move reverser by operating the magnet valve or with the wooden wedge.

2. WHAT IS THE PURPOSE OF THE BATTERY CHARGING AMMETER ON T CLASS LOCOMOTIVES?

To indicate to the Driver whether the Battery is or is not being charged when the engine is running.
3. WHAT WOULD YOU DO IF YOU OBSERVED A DISCHARGE ON THE BATTERY CHARGING AMMETER?

(a) Examine and test Aux. Gen. (AUX. GEN.) 150 amp fuse.

(b) T.320 - T.346 only. Examine Reverse Current Relay R.C.R. and see that the INNER contacts are closed, if not report to Train Control.

(c) Examine and close Auxiliary Generator Knife switch.

(d) Examine the Auxiliary Generator circuit breaker on T.347 - T.356 the Battery Charging contactor may be tested by operating the Auxiliary Generator circuit breaker.

4. WHAT WOULD YOU DO IF THE ENGINE STOPS?

(a) Examine the throttle to see that it is not at STOP.

(b) Check Control and Fuel Pump switch on Driver's panel.

(c) Check Engine Run switch on Driver's panel.

(d) Test and reset Control Circuit Breaker on Starting panel.

(e) Test and reset Fuel Pump circuit breaker on Starting panel.

(f) Check the Engine Relay (E.R.) which may be heard operating, by switching on and off the Engine Run Switch.

(g) Examine and reset the Ground Relay (G.R.)

(h) Check the Fuel Pump contactor (F.P.C.) which may be heard operating by putting the reverser in neutral and switching on and off the Control and Fuel Pump Switch.

(i) Examine and close Control Knife Switch.
(j) Examine and if necessary reset the Overspeed Trip Lever.

**NOTE.** This may be due to seized injectors which can be detected by trying to move the lay shaft.

(k) Examine the governor and see if the Low Oil pressure button is tripped. If tripped then press in and start engine. (Do not push in too far.)

(l) Examine Governor oil lever. If no oil in glass, get permission to put oil in the governor.

(m) Examine the fuel in the bypass glass. The one nearest the engine should be full of fuel, the other glass empty.

(n) Examine the fuel pump and connections also fuel pipes for leaks.

(o) Determine the amount of fuel in the tank.

5. **WHAT WOULD YOU DO IF YOU OPENED THE THROTTLE AND THE ENGINE DID NOT REV UP AND LOCO. MOVED SLOWLY OR NOT AT ALL?**

(a) Check Engine Run Switch on Driver's panel.

(b) Check Control and Fuel pump switch on Driver's panel.

(c) Examine and reset Control circuit breaker on Starting panel.

**NOTE.** After a few minutes engine will shut down.

(d) Check the Engine Relay (E.R.) which may be heard operating, by switching on and off the Engine Run Switch.

(e) Examine and reset the Ground Relay.
6. WHAT WOULD YOU DO IF ONE UNIT OF A MULTIPLE UNIT FAILED?

(a) Bearing in mind that the section must be cleared as soon as possible make a quick inspection and if possible rectify the fault.

(b) If unable to quickly locate the fault, use the good unit or units to haul the train.

(c) Inform Control of the failure at the first staff station, and then if possible immediately continue on with the train until instructed otherwise. On these T class locos the reverser should be locked in neutral when being towed.

7. WHAT WOULD YOU DO IF THE ALARM BELL RANG AND THE HOT ENGINE LIGHT SHOWED?

(a) Keep the train moving and clear the section.

(b) On arrival at the staff station inspect the Locomotive to find the cause of the Hot Engine.

(c) The Hot Engine may be due to the magnet valves not opening the shutters. If the shutters are closed manually operate the magnet valves and wedge the shutters in the open position.

(d) If the bell is still ringing and there is no water in the glass when the engine is running, inform Train Control and act under instructions.

NOTE. T Class locomotives can run so long as there is any water showing in the glass when the engine is running.
## QUESTIONS AND ANSWERS FOR
## T CLASS LOCOMOTIVES T.357 ONWARDS.

### 1. WHAT WOULD YOU DO IF YOU OPENED THE THROTTLE AND GOT NO POWER TO MOVE THE TRAIN ALTHOUGH THE ENGINE SPEED INCREASED?

(a) If power has not been obtained since the engine was started up, then examine the Starting Contactor. The three yellow dots seen through the perspex porthole should be in line.

(b) Check Generator Field switch on the Driver's panel and if defective advise Train Control.

(c) See that the reverser handle is in the correct position.

(d) Check and test 80 amp Battery Field fuse and if defective replace with a tested fuse.

(e) Examine the Forward and Reverse (FOR) & (REV) Relays. The yellow dots seen through the porthole should be V shaped on the Relay corresponding to the position of the reverser handle while the other Relay would have the yellow dots in line. If defective advise Train Control.

(f) Examine the Shunt Field and Battery Field Contactors. When the throttle is put to No.1 position the contactors operate and only one yellow dot is seen through the slots. If defective advise Train Control.

(g) Put the reverser to neutral and examine the 3 power contactors which should all be open, if not prise them open with the wooden wedge.

(h) Examine the Reverser Contactors: (RVF1 - RVR2 - RVF3 - RVR4). If in forward gear, on RVF1 and RVF3 the small square section should be up, while on RVR2 and RVR4 it should be down, and vice versa in reverse
gear. If all square sections are down, move reverser handle to opposite gear and see if contactors operate then put back reverser handle to original position and check again. If defective advise Train Control.

(i) Check Local Control Circuit breaker, if defective advise Train Control.

2. WHAT IS THE PURPOSE OF THE BATTERY CHARGING AMMETER?

To indicate to the Driver whether or not the battery is being charged while the engine is running.

3. WHAT WOULD YOU DO IF YOU OBSERVED A DISCHARGE ON THE BATTERY CHARGING AMMETER WHILE THE ENGINE IS RUNNING?

(a) Remove and test 30 amp. (AUX. GEN. FLD. or V.R.) fuse. Note spare wire is contained in fuse.

(b) With 30 amp fuse removed, remove and test 150 amp. (AUX. GEN.) fuse and replace if blown.

(c) Replace 30 amp fuse.

4. WHAT WOULD YOU DO IF THE ENGINE STOPS?

(a) Examine throttle to see if it is not at STOP.

(b) Check Control and Fuel Pump switch on Driver's panel.

(c) Check Engine Run Switch on Driver's panel.

(d) Test Control circuit breaker on Starting panel.

(e) Test Fuel Pump circuit breaker on Starting panel.

(f) Check Engine Relay by switching on and off Engine Run switch and observing movement inside of nylon section.
(g) Reset the Ground Relay.

(h) Examine the Fuel Pump Contactor. The 3 yellow dots should be V shaped.

(i) Reset the Overspeed Trip.

**NOTE.** This may be due to seized injectors which can be detected by trying to move the layshaft.

(j) Examine the governor and see if the Low Oil pressure button is tripped, if tripped press in and start engine. (Do not push in too far).

(k) Examine the governor oil level. If no oil in glass get permission to put some in the governor.

(l) Examine the fuel by-pass glass and the fuel return glass. The one nearest the engine should be full of clear fuel, the other one empty.

(m) Examine the fuel pump, connections also fuel pipes for leaks.

(n) Determine the amount of fuel in the tank.

5. **WHAT WOULD YOU DO IF YOU OPENED THE THROTTLE AND GOT NO POWER OR REV'S?**

(a) Examine Control and Fuel pump Switch on Driver's panel. (Engine will shut down in a few minutes).

(b) Examine Engine Run Switch on Driver's panel.

(c) Test Control circuit breaker on Starting panel.

(d) Examine Engine Relay by switching On and Off the Engine Run Switch and observing movement inside of nylon section.

(e) Reset Ground Relay.
6. WHAT WOULD YOU DO IF THE ALARM BELL RANG AND THE HOT ENGINE LIGHT SHOWED?

(a) Keep the train moving and clear the section.
(b) On arrival at the staff station inspect the locomotive to find the cause of the hot engine.
(c) If the bell is still ringing or the water is out of sight in the glass when the engine is running inform Train Control.

NOTE. T Class engine can run so long as there is any water showing in the glass when the engine is running.

7. WHAT WOULD YOU DO IF ONE UNIT OF A MULTIPLE UNIT FAILED?

(a) Bearing in mind that the section must be cleared as soon as possible make a quick inspection and if possible rectify the fault.
(b) If unable to quickly locate the fault use the good unit to haul the train.
(c) Inform Control of the failure at the first staff station and then if possible immediately continue on with the train until instructed otherwise. On T.357 onwards when the locomotive is being towed the reverser handle must be removed, the Local Control circuit breaker put to OFF and the Isolation Switch to Start.
QUESTIONS AND ANSWERS FOR Y CLASS LOCOMOTIVES.

These are the same as for T class Locomotives T 357 and onwards with the following exceptions:

There is no Shunt Field Contractor.

There are no Power Contractors.

It must also be noted that when being towed, the positions of the Automatic and Independent Brake Valve handles are not the same as on T class Locomotives.
Y Classs
101 — 175
TRANSITION

Two types of traction motor electrical circuit connections are used so that full power may be obtained at all times from the main generator within its current and voltage limits.

1. Parallel for starting and medium speeds.

2. Parallel with traction motor fields shunted for higher speeds.

The change from one type of connection to the other is called Transition.
Path of the Water

1. The PUMP forces water through the engine.
2. Heated discharge water from the engine flows to the RADIATORS.
3. A COOLING FAN directly driven from the engine causes air circulation through the radiators to cool the water.
4. Water from the radiators passes through the LUBRICATION OIL COOLER before returning to the engine pump.
5. A thermostatically operated BY-PASS VALVE at the radiator cooling water inlet controls water flow through the radiator to maintain a constant engine water temperature.
6. A WATER HEADER TANK provides a reserve of cooling water to make up for losses and maintains a positive head on the water system.
Air System—

1. Normal Operation — The governor controls the compressor — Valves should be as indicated in the diagram.

2. Permanently Unloaded — by turning the by-pass valve handle horizontal, air from the main reservoir goes direct into the unloader line, this prevents the compressor from pumping.

3. Permanently Loaded — By turning the governor cut-off valve horizontal, air from the main reservoir is cut off from the governor and unloader lines. The compressor will pump continuously. Pressure will go up to the safety valve limit of 150 lbs.
GENERATOR LOAD CONTROL

Load Regulator:

The load regulator is located on the right-hand side of the locomotive at the rear of the equipment rack. Its function is to control automatically the loading of the engine by the main generator, so that a predetermined power output is obtained for each position of the throttle. The load regulator is an automatically operated rheostat connected in series with the main generator battery field. (This is a low voltage externally excited field).

The load regulator is in minimum field when the contact arm is in the ten o'clock position. Maximum Field is obtained when the brush arm is in the two o'clock position.
ELECTRICAL CONTROLS

Console Top Electrical Cabinet (Auxiliary Distribution Panel)

1. Auxiliary Generator Field 30 Amp Fuse.
2. Ground Relay Cutout—To be opened only as directed.
3. Fuse Test—Fuses may be tested in the following manner —
   
   (a) Switch on small switch above the test points and fuse test light at the top should light. Failure of this bulb to light indicates that the bulb has blown and must be replaced before continuing the test, a replacement bulb can be obtained by utilising one from the step lights.
   
   (b) Place switch in the off position.
   
   (c) Place fuse across the blocks and the bulb will light if the fuse is satisfactory.
4. 80 Amp Battery Field Fuse.
5. 150 Amp Auxiliary Generator Fuse.
6. 400 Amp Starting Fuse.
7. Battery Knife Switch.
8. Ground Protective Relay (GR) — Provides protection for equipment against earthing of high voltage.
9. Voltage Regulator (VR) — Maintains the auxiliary generator output at a fixed voltage.
Electrical Controls—(Cont’d.)

Console Bottom Electrical Cabinet (Distribution Panel)
Electrical Controls—(Cont'd)

Console Bottom Electrical Cabinet (Distribution Panel)

1. Field Shunt Delay Relay (FSD) — Delays closing of Field Shunting contactors until main generator output is reduced.

2. Reverse Relay (RER) — Controls the low voltage circuits for reverse travel.

3. Forward Relay (FOR) — Controls the low voltage circuits for forward travel.

4. Fuel Pump Contactor (FPC) — Connects the fuel pump to the battery and is energised when the control and fuel pump switch is closed.

5. Battery Field Contactor (BF) — Connects the main generator battery field to low voltage.

6. Engine Relay (ER) — Controls the circuit from the throttle to the governor.

7. Voltage Limit Relay (VLR) — Limits main generator voltage to predetermined limits.

8. Voltage Regulating Tube (VRT) — Energises voltage limit relay at predetermined voltage.

1. Field Shunting Relay (FSR) — Operates at predetermined main generator current and voltage conditions to cause traction motor fields to be shunted.
2. Field Shunting Contactor (FS) — Connects shunts across the traction motor field windings.

3. Starting Contactor (GS) — Connects the battery to the main generator for turning the engine over.

4. Reverser Contactors — Change traction motor connections to reverse the direction of the locomotive.

5. Wheel Slip Relays (WSR) — Light the cab indicator and reduce power to the traction motors when wheels slip.
T Class
320 – 346
Variations and Similarities of T Class and H Class locomotives.

1. Transition

T 320 – 406, 413 + H classes all the same.

2. Reversers for Towing

Air operated T 320 – 356 + 413 the same.
Electric Operated T 357 – 406 + H classes the same.

3. Cooling System

T 320 – 356 + 413 the same.
T 357 – 406 + H classes the same.

4. Lubricating System

T 320 – 356 + 413 the same.
T 357 – 406 + H classes the same.

5. Fuel System

T 320 – 406, 413 + H classes all the same.

6. Air Compressor

T 320 – 406, 413 + H classes all the same.

7. LooD Regulator

T 320 – 406, 413 + H classes all the same.
TRANSITION

Model G8

Three types of traction motor electrical circuit connections are used so that full power may be obtained at all times from the main generator within its current and voltage limits.

1. Series Parallel—for starting and heavy pulling.

2. Parallel—for medium speeds.

3. Parallel with traction motor fields shunted—for higher speeds.

The change from one type of connection to another is called Transition and is effected automatically.
Towing the Locomotive

1. Remove the reverser handle.
   - The reverser switch must be centred in the neutral position. The locking pin normally carried on the left side of the reverser switch should be inserted from the right side and screwed home to lock the reverser.

2. Isolation switch should be in START position.
3. Brake valve isolating cock should be closed.
Path of the Water

1. The PUMP drives water through the engine to cool the cylinders.
2. The RADIATORS receive this water and the heat is given up to the atmosphere.
3. The COOLING FAN and SHUTTERS control the amount of air flowing through the radiators. Thermostats control the operation of cooling fan and shutters.
4. The LUBRICATING OIL COOLER uses the water to remove heat from the engine lubricating oil.
5. The TANK
   — provides a reservoir for water draining from the radiators when the engine shuts down.
   — provides a reserve of water to make up for evaporation.
Path of the Oil

1. The PRESSURE PUMP delivers oil to the engine where it lubricates and cools the engine parts.
2. The engine sump receives the oil when it has finished its job.
3. A STRAINER prevents particles from damaging
4. the SCAVENGING PUMP, which delivers oil to
5. the OIL COOLER where the heat in the oil is given to the engine cooling water.
6. thence to the OIL FILTER where the oil is cleaned.
7. The SUCTION STRAINERS prevent particles from damaging the pressure pump which sends oil back through the system.
 — Surplus oil overflows to the engine sump.
Path of the Fuel

1. Provided the EMERGENCY FUEL CUT-OFF SWITCHES (where fitted) are closed,
2. the CONTROL circuit breaker and switch in the cab closes the circuit to
3. the FUEL PUMP RELAYS in all locomotive units.
4. When the FUEL PUMP CIRCUIT BREAKER in each unit is ON, the fuel pump will run.
5. The TANK where the fuel is stored supplies fuel through
6. the SUCTION FILTER to protect
7. the PUMP which delivers fuel through
8. the DISCHARGE FILTER and
9. the SINTERED BRONZE filter where all remaining foreign matter is removed before fuel goes to
10. the INJECTORS. The injectors measure, time and atomise the fuel while injecting it into the cylinders.
11. The SIGHT GLASS shows surplus fuel returning to the tank. This provides a visual indication of fuel flow.
Path of the Air

1. The AIR FILTER cleans the air before passing it to the LOW PRESSURE CYLINDERS. Air is pumped up to about 30 lbs. pressure and discharged into
2. the INTERCOOLER. Here the air is cooled and discharged to
3. the HIGH PRESSURE CYLINDER, whence it is discharged at about 120 lbs. pressure into the MAIN RESERVOIR.
4. When the MAIN RESERVOIR reaches its maximum pressure, it unseats a piston in
5. the AIR COMPRESSOR GOVERNOR.
6. The UNLOADER LINES carry air pressure to the unloader pistons.
   — the pressure in the unloader lines holds the suction valves off their seats. Thus no air is compressed as the compressor rotates. The air goes in and out through the breathers.
AIR SYSTEM (Cont'd.)

Air Compressor Loaded

When the pressure in the main reservoir is reduced, a spring in the governor forces the governor piston down and closes off the air from the main reservoir. This causes the suction valves to seat and the compressor to start pumping.

Intercooler Pressure

Intercooler gauge should register approximately 30 lbs. pressure when the compressor is pumping.

— Relief valve is set at 50 lbs.
— If the pressure with the compressor pumping is substantially higher or lower than 30 lbs., it should be reported.

Intercooler gauge should register approximately 30 lbs. pressure when the compressor is pumping.

— Relief Valve is set at 50 lbs.
— If the pressure with the compressor pumping is substantially higher or lower than 30 lbs., it should be reported.

Main Reservoir Pressure

Pressure should be 110 to 120 lbs.
— Control is automatic, but can be controlled manually.
Air System—(Cont’d.)

Manual Control of Air Pumping

In emergencies it may be necessary to control the loading and unloading of the compressor manually.

1. Normal Operation — The governor controls the compressor—Valves should be as indicated in the diagram.

2. Permanently Unloaded — By turning the by-pass valve handle up, air from the main reservoir goes direct into the unloader line, this prevents the compressor from pumping.

3. Permanently Loaded — By turning the governor cut-off valve up, air from the main reservoir is cut off from the governor and unloader lines. The compressor will pump continuously. Pressure will go up to the safety valve limit of 150 lbs.

Lubricating Oil Pressure and Level
Oil level should be visible.
The load regulator is located on the right hand side of the locomotive at the rear of the equipment rack. Its function is to control automatically the loading of the engine by the main generator, so that a predetermined power output is obtained for each position of the throttle. The load regulator is an automatically operated rheostat connected in series with the main generator battery field. (This is a low voltage externally excited field.)

The load regulator is in minimum field when the brush arm is in the four o'clock position. Maximum field is obtained when the brush arm is in the eight o'clock position.
1. Ground relay cutout—Not to be opened by engine crews. Opens circuit to ground relay for maintenance purposes.
2. Battery charging contactor (BC)—Connects the battery to the auxiliary generator when the engine is running. Controlled by the reverse current relay (RCR).

3. Reverse current relay (RCR)—When current flows from the auxiliary generator towards the battery, it closes the battery charging contactor (BC). When the current reverses, it opens the battery charging contactor.

4. Battery field contactor (BF)—Connects the main generator battery field to low voltage.

5. Shunt field contactor (SF)—Connects the main generator shunt field to the high voltage.

6. Distribution panel—Knife switches and fuses on the panel, described, as used, elsewhere in this book.

7. Fuse test—Lay the fuse to be tested across the brass blocks. If the fuse is good the light should shine. To test this light turn the toggle switch ON and OFF.

8. Battery charging ammeter—Should read zero or slight charge at all times with engine running.

9. Forward transition relay (FTR)—Operates transition and energises field shunting contactors at predetermined main generator voltages. On locomotives not fitted with series parallel to parallel transition this relay is replaced by a field shunt relay (FSR) which energises field shunting contactors only.

10. Reverser—Changes traction motor connections to reverse the direction of the locomotive movement.

11. Engine relay (ER)—Controls the circuit from the throttle to the governor.

12. Fuel pump contactor (FPC)—Emergency feature. Makes it possible for driver to stop all fuel pumps from one cab by opening control switch on driver's control panel.

13. Power contactors (where fitted)—Connect the traction motors to the main generator.
14. Brake transfer switch or Cam switch (BKT) (where fitted)—During dynamic braking connects the traction motor armatures to the braking grids and establishes braking fields.

15. Field shunting contactor (FS)—Connects shunt across the traction motor field windings. The contactor is energised by forward transition relay (FTR) or field shunting relay (FSR).

16. Time delay centering relay (TDC) (where fitted)—Delays centering of self-centering reverser to allow current time to "die".

17. Time delay sanding relay (TDS) (where fitted)—Initiates sanding automatically, for approximately 10 seconds when wheel creep or wheel slip relays operate.

18. Reverse relay (RR) (where fitted)—Completes the low voltage circuit to the forward and reverse relays for self-centering.

19. Transition relay (TR) (where fitted)—Controls transition from series parallel to parallel and back.

20. Ground protective relay (GPR)—Provides protection for equipment against earthing of high voltage.

21. Pneumatic safety control relay (PCR) (where fitted)—Safety control switch operates this relay—Reduces engine speed to idle.

Control air pressure regulator—Reduces main reservoir pressure for use in operating pneumatic electric contactors, reverser and cam switches (if fitted), and is mounted on the main reservoir frame.

Wheel creep relay (WCR) (where fitted) (fitted where brake transfer switch is shown)—Wheel slip is anticipated and sanding relay is energised to initiate automatic sanding.
Hood Side of Electrical Cabinet

1. Voltage regulator (VR)—Maintains the auxiliary generator output at a fixed voltage.
2. Starting contactor (GS)—Connects the battery to the main generator for turning the engine over.
3. Wheel slip relays (WSR)—Light the cab indicator and reduce power to the traction motors when wheels slip.
4. Backward transition relay (BTR) (where fitted) — Protects the generator by changing the traction motor connections from parallel to series parallel.

5. Dynamic brake relay (BR) (where fitted) — Completes the dynamic brake control circuit.

6. Load regulator positioner (LRP) (where fitted) — Completes the dynamic brake control circuit.

7. Shunt field transfer relay (SFT) (where fitted) — Completes generator shunt field across traction motor output during dynamic braking.

8. Generator field contactor (GF) (where fitted) — Connects the main generator shunt field to high voltage.

9. Time delay relay—Brake control (TDB) (where fitted) — Delays the pick-up of the brake transfer switch to allow the main generator field time to "die".

10. Brake warning relay (BWR) (where fitted) — Lights the brake warning lamp to indicate overload during dynamic braking.

11. Dynamic brake regulator (DBR) (where fitted) — Regulates the shunt field excitation and therefore traction motor output during dynamic braking.

T Class
347 – 356
1. Ground relay cutout — To be opened only as directed.
2. Battery charging contactor (BC) — Connects the battery to the auxiliary generator when the engine is running. Controlled by the reverse current relay (RCR).
3. Reverse current relay (RCR) — When current flows from the auxiliary generator towards the battery, it closes the battery charging contactor.

4. Battery field contactor (BF) — Connects the main generator battery field to low voltage.

5. Shunt field contactor (SF) — Connects the main generator shunt field to the high voltage.

6. Distribution panel — Knife switches and fuses on the panel, described, as used, elsewhere in this book.

7. Fuse Test — Fuses may be tested in the following manner —
   (a) Switch on small switch above the test points and fuse test light at the top should light. Failure of this bulb to light indicates that the bulb has blown and must be replaced before continuing the test, a replacement bulb can be obtained by utilising one from the step lights.
   (b) Place switch in the off position.
   (c) Place fuse across the brass blocks and the bulb will light if the fuse is satisfactory.

8. Field shunting contactor (FS) — Connects shunt across the traction motor field windings. The contactors are energised by forward transition relay (FTR).

9. Forward transition relay (FTR) — Operates transition and energises field shunting contactors at predetermined main generator voltages.

10. Reverser — Changes traction motor connections to reverse the direction of the locomotive movement.

11. Engine relay (ER) controls the circuit from the throttle to the governor.

12. Fuel pump contactor (FPC) — Connects the fuel pump to the battery and is energised when the control switch is CLOSED.
13. Power contactors — Connect the traction motors to the main generator.

14. Ground protective relay (GPR) — Provides protection for equipment against earthing of high voltage.

15. Time delay centering relay (TDC) — Delays centering of self-centering reverser to allow current time to "die."

16. Reverser relay (RR) — Completes the low voltage circuit to the forward and reverse relays for self-centering.

17. Transition relay (TR) — Controls transition from series parallel to parallel and back.

Control air pressure regulator — Reduces main reservoir pressure for use in operating pneumatic electric contactors, reverser and is mounted on the main reservoir frame in the short hood end of the locomotive.
Hood Side of Electrical Cabinet

1. Voltage regulator (VR) — Maintains the auxiliary generator output at a fixed voltage.
2. Starting contactor (GS) — Connects the battery to the main generator for turning the engine over.
3. Wheel slip relays (WSR) — Light the cab indicator and reduce power to the traction motors when wheels slip.
4. Backward transition relay (BTR) — Protects the generator by changing the traction motor connections from parallel to series parallel.
T Class
357 – 366
Towing the Locomotive

1. Remove Jumper cable between units.
2. Remove the reverser handle from the controller.
3. Isolating switch should be in START position.
4. Local control circuit breaker to be switched OFF.
5. The brake valve isolating cock should be closed.
COOLING SYSTEM

Path of the Water

1. The PUMP forces water through the engine.

2. Heated discharge water from the engine flows to the RADIATORS.

3. A COOLING FAN directly driven from the engine causes air circulation through the radiators to cool the water.

4. Water from the radiators passes through the LUBRICATING OIL COOLER before returning to the engine pump.

5. A thermostatically operated BY-PASS VALVE at the radiator cooling water inlet controls water flow through the radiator to maintain a constant engine water temperature.

6. A WATER HEADER TANK provides a reserve of cooling water to make up for losses and maintains a positive head on the water system.
LUBRICATION SYSTEM

Path of the Oil

Oil from the engine sump is drawn through the

1. SCAVANGE OIL STRAINER by the
2. SCAVANGE PUMP which delivers oil to the
3. MICHIANA FILTER where the oil is cleaned
   before passing to the
4. LUBE OIL COOLER where heat in the oil is
   given up to the engine cooling water. The
   Pressure pump.

5. SUCTION STRAINERS prevent particles from
   damaging the

6. PRESSURE PUMP which delivers oil to the
   engine where it lubricates and cools the
   engine parts — Surplus oil overflows to the
   engine sump. A by-pass fitted with a

7. BY-PASS valve and

8. SIGHT GLASS is connected between the in-
   let to the lube oil filter and the discharge
   side of the lube oil cooler and permits circu-
   lation of cold oil or oil volume in excess of
   filter capacity.
1. Auxiliary Generator Field 30 Amp Fuse.
2. Ground relay cutout — To be opened only as directed.
3. Fuse Test — Fuses may be tested in the following manner —
ELECTRICAL CONTROLS (Cont’d.)

(a) Switch on small switch above the test points and fuse test light at the top should light. Failure of this bulb to light indicates that the bulb has blown and must be replaced before continuing the test, a replacement bulb can be obtained by utilising one from the step lights.
(b) Place switch in the off position.
(c) Place fuse across the brass blocks and the bulb will light if the fuse is satisfactory.

4. 80 Amp Battery Field Fuse.
5. 150 Amp Auxiliary Generator Fuse.
6. 400 Amp Starting Fuse.
7. Field Shunt Delay Relay FSD—Delays closing of Field Shunt Contactor until main Generator output is reduced.
8. Battery Knife Switch.
9. Transition relay (TR) — Controls transition from series parallel to parallel and back.
10. Reverse Relay (RER) — Controls the low voltage circuits for reverse travel.
11. Forward Relay (FOR) — Controls the low voltage circuits for forward travel.
12. Fuel pump contactor (FPC) — Connects the fuel pump to the battery and is energised when the control and fuel pump switch is CLOSED.
13. Transition setting resistors.
14. Battery field contactor (BF) — Connects the main generator battery field to low voltage.
15. Shunt field contactor (SF) — Connects the main generator shunt field to the high voltage.
16. Engine relay (ER) controls the circuit from the throttle to the governor.
17. Ground protective relay (GPR) — Provides protection for equipment against earthing of high voltage.
18. Voltage regulator (VR) — Maintains the auxiliary generator output at a fixed voltage.
19. Forward Transition Relay (FTR) — Operates at predetermined main generator current and voltage conditions to cause the traction motor fields to be shunted.

20. Parallel Transition Relay (PTR) — Operates at predetermined Main Generator current and voltage conditions to change traction motor connections from Series Parallel to Parallel.

21. Reverser Contactors — Change traction motor connections to reverse the direction of the locomotive.

22. Field shunting contactor (FS) — Connects shunts across the traction motor field windings. The contactors are energised by forward transition relay (FTR).

23. Starting contactor (GS) — Connects the battery to the main generator for turning the engine over.
Electrical Controls—(Cont'd)

Hood Side of Electrical Cabinet

1. Power Contactors — Connect the traction motors to the main generator.

2. Wheel slip relays (WSR) — Light the cab indicator and reduce power to the traction motors when wheels slip.
T Class

367 – 398
1. Auxiliary Generator Field 30 Amp Fuse.

2. Ground Relay Cutout—To be opened only as directed.

3. Fuse Test—Fuses may be tested in the following manner —
Electrical Controls—(Cont'd.)

(a) Switch on small switch above the test points and fuse test light at the top should light. Failure of this bulb to light indicates that the bulb has blown and must be replaced before continuing the test, a replacement bulb can be obtained by utilising one from the step lights.

(b) Place switch in the off position.

(c) Place fuse across the brass blocks and the bulb will light if the fuse is satisfactory.

4. 80 Amp Battery Field Fuse.
5. 150 Amp Auxiliary Generator Fuse.
6. 400 Amp Starting Fuse.
7. Field Shunt Delay Relay FSD—Delays closing of Field Shunt Contactor until main Generator output is reduced.
8. Battery Knife Switch.
9. Transition relay (TR) — Controls transition from series parallel to parallel and back.
10. Reverse Relay (RER)—Controls the low voltage circuits for reverse travel.
11. Forward Relay (FOR)—Controls the low voltage circuits for forward travel.
12. Fuel pump contactor (FPC)—Connects the fuel pump to the battery and is energised when the control and fuel pump switch is CLOSED.
13. Transition setting resistors.
14. Battery field contactor (BF)—Connects the main generator battery field to low voltage.
15. Shunt field contactor (SF)—Connects the main generator shunt field to the high voltage.
16. Engine relay (ER) controls the circuit from the throttle to the governor.
Electrical Controls—(Cont’d.)

17. Ground protective relay (GPR)—Provides protection for equipment against earthing of high voltage.

18. Voltage regulator (VR) — Maintains the auxiliary generator output at a fixed voltage.

19. Forward Transition Relay (FTR)—Operates at predetermined main generator current and voltage conditions to cause the traction motor fields to be shunted.

20. Parallel Transition Relay (PTR)—Operates at predetermined Main Generator current and voltage conditions to change traction motor connections from Series Parallel to Parallel.

21. Wheel Slip Relays (WSR)—Light the cab indicator and reduce power to the traction motors when wheels slip.
Electrical Controls—(Cont’d.)

Hood Side of Electrical Cabinet

1. Power Contactors—Connect the traction motors to the main generator.

2. Reverser Contactors RVF1, RVR2, RVF3, RVR4 — Change traction motor connections to reverse the direction of the locomotive.

3. Field shunting contactor (FS)—Connects shunts across the traction motor field windings. The contactors are energised by forward transition relay (FTR).

4. Starting contactor (GS)—Connects the battery to the main generator for turning the engine over.

5. Battery Charging Resistor

6. Main Generator Shunt Field Resistor
T Class
399 – 406
1. Auxiliary Generator Field 30 Amp Fuse.

2. Ground Relay Cutout—To be opened only as directed.

3. Fuse Test—Fuses may be tested in the following manner —
Electrical Controls—(Cont'd.)

(a) Switch on small switch above the test points and fuse test light at the top should light. Failure of this bulb to light indicates that the bulb has blown and must be replaced before continuing the test, a replacement bulb can be obtained by utilising one from the step lights.

(b) Place switch in the off position.

(c) Place fuse across the test blocks and the bulb will light if the fuse is satisfactory.

4. 80 Amp Battery Field Fuse.
5. 150 Amp Auxiliary Generator Fuse.
6. 400 Amp Starting Fuse.
7. Field Shunt Delay Relay FSD—Delays closing of Field Shunt Contactor until main Generator output is reduced.
8. Battery Knife Switch.
9. Transition relay (TR) — Controls transition from series parallel to parallel and back.
10. Reverse Relay (RER)—Controls the low voltage circuits for reverse travel.
11. Forward Relay (FOR)—Controls the low voltage circuits for forward travel.
12. Fuel pump contactor (FPC)—Connects the fuel pump to the battery and is energised when the control and fuel pump switch is CLOSED.
13. Transition setting resistors.
14. Battery field contactor (BF)—Connects the main generator battery field to low voltage.
15. Shunt field contactor (SF)—Connects the main generator shunt field to the high voltage.
16. Engine relay (ER) controls the circuit from the throttle to the governor.
17. Ground protective relay (GR)—Provides protection for equipment against earthing of high voltage.

18. Voltage regulator (VR) — Maintains the auxiliary generator output at a fixed voltage.

19. Forward Transition Relay (FTR)—Operates at predetermined main generator current and voltage conditions to cause the traction motor fields to be shunted.

20. Parallel Transition Relay (PTR)—Operates at predetermined Main Generator current and voltage conditions to change traction motor connections from Series Parallel to Parallel.

21. Wheel Slip Relays (WSR)—Light the cab indicator and reduce power to the traction motors when wheels slip.
1. Power Contactors—Connect the traction motors to the main generator.

2. Reverser Contactors RVF1, RVR2, RVF3, RVR4 — Change traction motor connections to reverse the direction of the locomotive.

3. Field shunting contactor (FS)—Connects shunts across the traction motor field windings. The contactors are energised by forward transition relay (FTR).

4. Starting contactor (GS)—Connects the battery to the main generator for turning the engine over.

5. Battery Charging Resistor

6. Main Generator Shunt Field Resistor
H1 – H5
(407 – 412)
To use Hump Speed Control

1. Place hump control switch in ON position. Hump control light will shine to indicate the feature is operative.

2. Manipulate the hump control rheostat for more precise control of locomotive power than is provided by the normal throttle settings. With the rheostat turned fully to the INCREASE position, full power appropriate to the throttle setting engaged will be developed. At any other position power will be reduced accordingly to allow speed to be adjusted to suit humping service operating conditions. Hump control may also be used in traffic to reduce power to just below the point of slip to control wheel slip caused by adverse adhesion conditions.
1. Auxiliary Generator Field 30 Amp Fuse.

2. Ground Relay Cutout—To be opened only as directed.

3. Fuse Test—Fuses may be tested in the following manner —
Electrical Controls—(Cont’d.)

(a) Switch on small switch above the test points and fuse test light at the top should light. Failure of this bulb to light indicates that the bulb has blown and must be replaced before continuing the test, a replacement bulb can be obtained by utilising one from the step lights.

(b) Place switch in the off position.

(c) Place fuse across the test blocks and the bulb will light if the fuse is satisfactory.

4. 80 Amp Battery Field Fuse.
5. 150 Amp Auxiliary Generator Fuse.
6. 400 Amp Starting Fuse.
7. Field Shunt Delay Relay FSD—Delays closing of Field Shunt Contactor until main Generator output is reduced.
8. Battery Knife Switch.
9. Transition relay (TR) — Controls transition from series parallel to parallel and back.
10. Reverse Relay (RER)—Controls the low voltage circuits for reverse travel.
11. Forward Relay (FOR)—Controls the low voltage circuits for forward travel.
12. Fuel pump contactor (FPC)—Connects the fuel pump to the battery and is energised when the control and fuel pump switch is CLOSED.
13. Transition setting resistors.
14. Battery field contactor (BF)—Connects the main generator battery field to low voltage.
15. Shunt field contactor (SF)—Connects the main generator shunt field to the high voltage.
16. Engine relay (ER) controls the circuit from the throttle to the governor.
Electrical Controls—(Cont'd)

17. Ground protective relay (GR)—Provides protection for equipment against earthing of high voltage.

18. Voltage regulator (VR) — Maintains the auxiliary generator output at a fixed voltage.

19. Forward Transition Relay (FTR)—Operates at predetermined main generator current and voltage conditions to cause the traction motor fields to be shunted.

20. Parallel Transition Relay (PTR) — Operates at predetermined Main Generator current and voltage conditions to change traction motor connections from Series Parallel to Parallel.

21. Wheel Slip Relays (WSR)—Light the cab indicator and reduce power to the traction motors when wheels slip.

22. Battery Charging Rectifier — Allows charging current to flow from the auxiliary generator to the battery when the engine is running and prevents a reverse flow of current when the engine is stopped.

23. Hump Relay (HR) — On closure of the hump control switch, makes the hump control rheostat operative on the driving unit and train lines the control for all units operating in multiple.

24. Hump Control Relay (HCR) — Controls positioning of the load regulator, in response to movement of the hump control rheostat, by acting on the governor overriding solenoid.
Electrical Controls—(Cont’d)

Hood Side of Electrical Cabinet

1. Power Contactors—Connect the traction motors to the main generator.

2. Reverser Contactors RVF1, RVR2, RVF3, RVR4—Change traction motor connections to reverse the direction of the locomotive.

3. Field shunting contactor (FS)—Connects shunts across the traction motor field windings. The contactors are energised by forward transition relay (FTR).

4. Starting contactor (GS)—Connects the battery to the main generator for turning the engine over.

5. Battery Charging Resistor

6. Main Generator Shunt Field Resistor
T Class
413 only
Dynamic Brake Principle

Electrical connections are made to convert the traction motors into generators.

Power required to rotate the "generators" retards the locomotive.

"Generator" output is dissipated in resistors or grids located in the short hood of the locomotive and cooled by a motor driven fan. Some of the power generated by the traction motors during dynamic braking drives the cooling fan motor.

The dynamic brake, although similar in effect to an independent air brake application, is fully electrical and does not produce friction between brake shoes and tyres, thus avoiding heat and wear on these parts.

The load indicating meter shows the current generated by the traction motors and may be compared in effect with a "brake cylinder pressure gauge".
DYNAMIC BRAKE OPERATION (Cont'd.)

To Use the Dynamic Brake

1. Reverser—must be positioned in the direction of locomotive movement.
2. Throttle—must be in IDLE.
3. Move the selector lever from RUN to OFF and through to B.
4. When the load indicating meter shows a current flow has been created, advance the selector lever in the brake regulation band to obtain the braking effort required.
5. To release dynamic brake, return the selector lever to the commencement of the brake regulation band, and when the load indicating meter fails to a steady reading move selector lever to B and through to OFF.

Dynamic Brake Characteristics

During dynamic braking, the interlock prevents application of the air brakes on the locomotive when the automatic brake is used to further reduce train speed.

In the event of an emergency brake application, the dynamic brake is automatically released and the air brake applied when the brake pipe pressure is reduced below 45 lbs./sq. inch.

The dynamic brake is most effective between speeds of 15 and 25 m.p.h.

The load indicating meter should not read above 300 amperes.

Dynamic Brake Warning Light

The flashing of the brake warning light indicates an overload in the braking system.

To rectify—reduce braking slightly until the light disappears.

The brake warning light must not remain on for more than 5 seconds.

The wheel slip light may also show during dynamic braking if slippery rail conditions are encountered.

CAUTION: DO NOT PLACE AN ENGINE “ON THE LINE” WHILE USING THE DYNAMIC BRAKE.

Speed on grades must not be allowed to creep up by careless handling of the dynamic brake.
1. Ground relay cutout—Not to be opened by engine crews. Opens circuit to ground relay for maintenance purposes.
ELECTRICAL CONTROLS (Cont'd.)

2. Battery charging contactor (BC)—Connects the battery to the auxiliary generator when the engine is running. Controlled by the reverse current relay (RCR).

3. Reverse current relay (RCR)—When current flows from the auxiliary generator towards the battery, it closes the battery charging contactor (BC). When the current reverses, it opens the battery charging contactor.

4. Battery field contactor (BF)—Connects the main generator battery field to low voltage.

5. Shunt field contactor (SF)—Connects the main generator shunt field to the high voltage.

6. Distribution panel—Knife switches and fuses on the panel, described, as used, elsewhere in this book.

7. Fuse test—Lay the fuse to be tested across the brass blocks. If the fuse is good the light should shine. To test this light turn the toggle switch ON and OFF.

8. Battery charging ammeter—Should read zero or slight charge at all times with engine running.

9. Forward transition relay (FTR)—Operates transition and energises field shunting contactors at predetermined main generator voltages. On locomotives not fitted with series parallel to parallel transition this relay is replaced by a field shunt relay (FSR) which energises field shunting contactors only.

10. Reverser—Changes traction motor connections to reverse the direction of the locomotive movement.

11. Engine relay (ER)—Controls the circuit from the throttle to the governor.

12. Fuel pump contactor (FPC)—Emergency feature. Makes it possible for driver to stop all fuel pumps from one cab by opening control switch on driver's control panel.

13. Power contactors (where fitted)—Connect the traction motors to the main generator.
14. Brake transfer switch or Cam switch (BKT) (where fitted)—During dynamic braking connects the traction motor armatures to the braking grids and establishes braking fields.

15. Field shunting contactor (FS)—Connects shunt across the traction motor field windings. The contactor is energised by forward transition relay (FTR) or field shunting relay (FSR).

16. Time delay centering relay (TDC) (where fitted) — Delays centering of self-centering reverser to allow current time to “die”.

17. Time delay sanding relay (TDS) (where fitted)—Initiates sanding automatically, for approximately 10 seconds when wheel creep or wheel slip relays operate.

18. Reverse relay (RR) (where fitted) — Completes the low voltage circuit to the forward and reverse relays for self-centering.

19. Transition relay (TR) (where fitted)—Controls transition from series parallel to parallel and back.

20. Ground protective relay (GPR)—Provides protection for equipment against earthing of high voltage.

21. Pneumatic safety control relay (PCR) (where fitted)—Safety control switch operates this relay—Reduces engine speed to idle.

Control air pressure regulator — Reduces main reservoir pressure for use in operating pneumatic electric contactors, reverser and cam switches (if fitted), and is mounted on the main reservoir frame.

Wheel creep relay (WCR) (where fitted) (fitted where brake transfer switch is shown)—Wheel slip is anticipated and sanding relay is energised to initiate automatic sanding.
Hood Side of Electrical Cabinet

1. Voltage regulator (VR)—Maintains the auxiliary generator output at a fixed voltage.
2. Starting contactor (CS)—Connects the battery to the main generator for turning the engine over.
3. Wheel slip relays (WSR)—Light the cab indicator and reduce power to the traction motors when wheels slip.
4. Backward transition relay (BTR) (where fitted) —Protects the generator by changing the traction motor connections from parallel to series parallel.
5. Dynamic brake relay (BR) (where fitted) —Completes the dynamic brake control circuit.
6. Load regulator positioner (LRP) (where fitted) —Keeps the excitation of the battery field at a value proportional to the setting of the dynamic brake selector lever.
7. Shunt field transfer relay (SFT) (where fitted) —Connects generator shunt field across traction motor output during dynamic braking.
8. Generator field contactor (GF) (where fitted) —Connects the main generator shunt field to high voltage.
9. Time delay relay—Brake control (TDB) (where fitted) —Delays the pick-up of the brake transfer switch to allow the main generator field time to "die".
10. Brake warning relay (BWR) (where fitted) —Lights the brake warning lamp to indicate overload during dynamic braking.
11. Dynamic brake regulator (DBR) (where fitted) —Regulates the shunt field excitation and therefore traction motor output during dynamic braking.
B Class
60 - 85
The electrical energy developed by the main generator is conducted to the Electrical Cabinets. In the Electrical Cabinets the current is distributed to six model D.27 Traction Motors which are geared to the wheels. The motors convert the electrical energy to mechanical energy for propelling the locomotive.

Current from the alternator and auxiliary generator is also distributed through the Electrical Cabinets.
CONVERSION TO MECHANICAL POWER (Cont'd.)

Two types of traction motor electrical connection are used so that full power may be obtained from the main generator within the range of its current and voltage limits, namely:

1. Series-parallel — for starting and heavy pulling.

![Diagram of Series-parallel connection]

2. Parallel — For higher speeds.

![Diagram of Parallel connection]

The change from one type of connection to another is called Transition and is effected automatically.
Path of the Water

1. The PUMP drives water through the engine to cool the cylinders.
2. The RADIATORS receive this water and the heat is given up to the air.
3. COOLING FANS control the amount of air through the radiators by operating in varying combinations.
4. THERMOSTATS cut the cooling fans in and out in accordance with engine temperature.
5. The LUBE OIL COOLER uses the water to remove heat from the engine lubricating oil.
6. THE TANK
   - Provides a reservoir of space for water draining from the radiators when the engine shuts down.
   - Provides surplus water to make up for evaporation.
LUBE OIL SYSTEM

Path of the Oil

1. The PRESSURE PUMP delivers the oil to the engine where it lubricates and cools the engine parts.
2. The ENGINE SUMP receives the oil when it has finished its job.
3. A STRAINER prevents particles from damaging
4. the SCAVENGER PUMP which sends oil to
5. the OIL FILTER where the oil is cleaned and
6. the LUBE OIL COOLER where the heat of the oil is given to the engine cooling water.
7. The SUCTION STRAINERS prevent particles from damaging the pressure pump which sends the oil back through the engine.
   - Surplus oil overflows to the engine sump.
Path of the Fuel

1. The FUEL PUMP SWITCH in the cab closes the circuit to
2. the FUEL PUMP relays in all locomotive units.
3. When the CIRCUIT BREAKERS in each unit are ON
4. and the FUEL PUMP SWITCH in each unit is closed, the fuel pump begins to run.
5. The TANK where the fuel is stored supplies fuel through
6. the EMERGENCY FUEL VALVE and from there to
7. the SUCTION FILTER to protect the pump.
8. The PUMP delivers the fuel through
9. the DISCHARGE FILTER and
10. the SINTERED BRONZE FILTER where all foreign matter is removed before the fuel goes to
11. the INJECTORS. The injectors measure, time and atomise the fuel while injecting it into the cylinders.
12. The SIGHT GLASS checks the surplus fuel on the way back to the tank. This provides a visual indication of fuel flow.
Path of the Air

1. The AIR FILTER cleans the air before passing it to
2. the LOW PRESSURE CYLINDERS. The air is pumped up to about 30 lbs. pressure and discharged into
3. the INTERCOOLER. The air is cooled and discharged to
4. the HIGH PRESSURE CYLINDER where it is pumped up to approximately 120 lbs. and discharged into the main reservoir.
AIR SYSTEM (Cont’d.)

Air Compressor Unloaded

5. When the MAIN RESERVOIR reaches its maximum pressure it unseats a piston in
6. the AIR COMPRESSOR GOVERNOR.
7. The UNLOADER LINES carry the air pressure to the compressor suction valves.
   - The pressure in the unloader lines holds the suction valves off their seats. Even though the compressor continues its rotation, no air is compressed. The air goes in and out through the breathers.

Air Compressor Loaded

When the pressure in the main reservoir is reduced, a spring in the governor forces the governor piston down and closes off the air from the main reservoir. This causes the suction valve to seat and the compressor to start pumping.

Lubricating Oil Pressure and Level

Pressure should be
   - 10 lbs. minimum at idle speed.

Intercooler Pressure

Intercooler gauge should register approximately 30 lbs. when the compressor is pumping.
   - relief valve is set at 50 lbs.
   - If the pressure with the compressor pumping is substantially higher or lower than 30 lbs. it should be reported.
Main Reservoir Pressure
Pressure should be 110 to 120 lbs.
— Control is automatic, but can be controlled manually.

Manual Control of Air Pumping
In emergencies it may be necessary to control the loading and unloading of the compressor manually.

1. Normal Operation
— The governor controls the compressor.
— Valves should be as indicated in the diagram.

2. Permanently Unloaded
— By turning the by-pass valve handle up, air from the main reservoir goes direct into the unloader line, this prevents the compressor from pumping.

3. Permanently Loaded
— By turning the governor cut-off valve up, air from the main reservoir is cut off from the governor and unloader lines. The compressor will pump continuously. Pressure will go up to the safety valve limit of 150 lbs.
Load Regulator - Description

The function of the load regulator is to vary the battery field current in the main generator.

The Load Regulator also
- Engages and disengages the TEASER circuit used for faster starting.
- Makes FORWARD TRANSITION, by changing the traction motor connections from SERIES-PARALLEL to PARALLEL.

The movement of the load regulator arm is controlled by the flow of oil from the engine governor.

Operation of the Load Regulator

A. Arm in minimum Field Position.

When the throttle is in idle
- the load regulator arm moves to the minimum field position.
- Finger "A" holds down the load regulator switch (LRS)
- In this position the "Teaser" circuit is partially established, and the amount of battery field current to the main generator is controlled by the throttle position through the A, B and C Teaser contactors in the No. 1 Electrical Cabinet.
B. Arm in Mid-Position.

As the locomotive gathers speed and the load regulator arm reaches mid-position
- Finger "B" trips LRS.
- The Teaser circuit is now inoperative and
- Main generator excitation is normal, being controlled by the movement of the load regulator arm.
- The Teaser circuit remains inoperative until the load regulator arm returns to minimum field and finger "A" trips LRS in the reverse direction.
This occurs every time the throttle is closed to IDLE.
When the load regulator arm reaches maximum field position
- Finger "C" closes the Forward Transition Switch (FTS) and causes FORWARD TRANSITION to take place
  - opening the SERIES-PARALLEL power Contactors S16, S23 and S45
  and closing the PARALLEL power Contactors P1, P2, P3, P4, P5 and P6.

As the load regulator arm moves away from the maximum field
- finger "C" moves away from FTS allowing it to assume normal position but
- the traction motors remain connected in parallel until either
  - Backward Transition takes place or
  - the throttle is closed to Idle, which changes the motors connections back to Series - Parallel.

Making Backward Transition
When the locomotive encounters a sufficiently heavy grade the current from the main generator reaches approximately 2500 amperes
- the Backward Transition Relay BTR in the No. 1 Electrical Cabinet is energized, causing
  - the P Contactors to open and
  - the S contactors to close.
- The traction motor connections have been changed from PARALLEL to SERIES - PARALLEL.
ELECTRICAL CONTROLS (Cont'd.)

Front of No. 1 Electrical Cabinet

1. TEASER CONTACTORS – used for fast starting of locomotive.

2. LOAD REGULATOR CONTACTOR – Controls the feed to the teaser contactors.

3. GROUND RELAY CUTOUT – Not to be opened by engine crews. Opens circuit to ground relay.

4. BATTERY CHARGING CONTACTOR – Connects the battery to the auxiliary generator when the engine is running. Controlled by the Reverse Current Relay.

5. REVERSE CURRENT RELAY – When current flows from the auxiliary generator toward the battery, it closes the B.C. When the current reverses it opens the B.C.
6. PARALLEL RELAY—Controls transitions from series to parallel and back.

7. TIME DELAY RELAY—Delays the opening of the main power contactors during transition to give the generator field time to die.

8. BATTERY FIELD CONTACTOR—Connects the main generator battery field to the low voltage.

9. SHUNT FIELD CONTACTOR—Connects the main generator shunt field to the high voltage.

10. NO VOLTAGE RELAY—Lights the alarm light and sounds the bell when there is no alternating current.

11. DISTRIBUTION PANEL—Switches, fuses and circuit breakers on the panel described, as used, elsewhere in this book.

12. FUSE TEST—Lay the fuse to be tested across the copper blocks. If the fuse is good, the light should shine. To test this light turn the toggle switch on and off.

13. BATTERY CHARGING AMMETER—Should read zero or show some charge at all times with engine running.
14. CONTROL AIR PRESSURE REGULATOR - Reduces main reservoir pressure for use in operating pneumatic-electric contactors.

15. WHEEL SLIP RELAY No. 1 - Lights the cab indicator, reduces the engine speed and load when the wheels slip. Connected to No. 1 and No. 3 traction motors.

16. BACKWARD TRANSITION RELAY - Protects the generator by changing circuits from parallel to series when the locomotive is heavily loaded.

17. ROAD SERVICE SWITCH
   - SWITCHING - Fast start using Teaser circuit
   - ROAD - Normal modified maximum field start.

18. BRAKE RELAY - Controls the dynamic braking effort.

19. BRAKE WARNING RELAY - Lights the brake warning light to indicate overload during dynamic braking.

20. BRAKING CONTACTOR - Connects the traction motor fields to the main generator during dynamic braking.
ELECTRICAL CONTROLS (Cont'd.)

REAR OF No. 1 ELECTRICAL CABINET
ELECTRICAL CONTROLS (Cont'd.)

Rear of No. 1 Electrical Cabinet

1. CAM SWITCH No. 1 — During dynamic braking connects No. 1, No. 2 and No. 3 traction motor armatures to the braking grids and establishes braking fields.

2. SIGNAL RELAY — Rings the alarm bell.

3. FUEL PUMP CONTACTOR — Emergency feature. Makes it possible for the driver to stop all fuel pumps from the cab.

4. ENGINE CONTROL RELAY — Controls circuit from the throttle to the governor.

5. VOLTAGE REGULATOR — Controls the auxiliary generator output to a fixed voltage.

6. STARTING CONTACTORS — Connect the battery to the main generator for turning the engine over.

7. REVERSER No. 1 — Changes the traction motor connections to reverse the direction of locomotive movement.

8. POWER CONTACTORS — Connect the traction motors with the main generator.
1. CAM SWITCH No. 2 – During dynamic braking connects No. 4, No. 5 and No. 6 traction motor armatures to the braking grids and establishes braking fields.

2. POWER CONTACTORS – Connect the traction motors to the main generator.

3. WHEEL SLIP RELAY No. 2 – Lights the cab indicator reduces the engine speed and load when the wheels slip. Connected to No. 4 and No. 6 traction motors.

4. REVERSER No. 2 – Changes the traction motor connections to reverse the direction of locomotive movement.
S Class

300 – 317
The electrical power developed by the main generator is distributed through the Electrical Cabinet to Traction Motors which are geared to the wheels. The motors convert the electrical power to mechanical power for propelling the locomotive.

Current from the alternator and auxiliary generator is also distributed through the electrical cabinet.

Four types of traction motor electrical circuit connections are used so that full power may be obtained at all times from the main generator without exceeding its current and voltage limits, namely:

1. Series parallel — Stage 1 — for starting and heavy pulling.
Conversion to Mechanical Power—(Cont'd.)

2. Series parallel —
   Stage 2—for normal running.

3. Stage 2 Series parallel with 46% shunting of motor fields — for higher speeds.

4. Stage 2 Series parallel with 74% shunting of motor fields—for still higher speeds.

The change from one type of connection to another is called Transition and is effected automatically.
HOSTLER CONTROL OPERATION

Driving the Locomotive from the Rear End

When leaving the Front Driving Cab—

1. Place selector handle in the OFF position.
2. Centre the reverse handle and remove.
3. Make a FULL SERVICE brake application with the automatic brake valve isolating cock.

   **CAUTION:** FAILURE TO CLOSE THE BRAKE VALVE ISOLATING COCK BEFORE PROCEEDING TO THE HOSTLERS END WILL PREVENT A BRAKE APPLICATION BEING MADE FROM THE HOSTLERS END.

4. Place the independent brake valve handle in LAP position and remove.
5. Place the automatic brake valve handle in RUNNING position and remove.
6. Place all switches on the drivers control panel in the OFF position.
7. Place the Hostler Control knife switch located in the electrical cabinet, in the HOSTLER CONTROL position.
8. Proceed to the rear of the locomotive.

When Entering Hostlers Compartment—

1. Unlock safety catch and place all switches on the control desk in the ON position.
2. Insert reverser handle and brake valve handles and place the independent brake valve in SLOW APPLICATION position.
3. Open the brake valve isolating cock.
4. Proceed with normal locomotive operation.

When leaving the Hostlers Compartment—

1. Centre the reverser handle and remove.
2. Make a FULL SERVICE brake application with the automatic brake valve and CLOSE the brake valve isolating cock.

CAUTION: FAILURE TO CLOSE THE BRAKE VALVE ISOLATING COCK BEFORE PROCEEDING TO THE FRONT DRIVING CAB WILL PREVENT A BRAKE APPLICATION BEING MADE FROM THE FRONT CAB.

3. Place the independent brake valve handle in LAP position and remove.
4. Place the automatic brake valve handle in RUNNING position and remove.
Driving the Locomotive from the Rear End—(Cont’d.)

5. Place all switches on the control desk in the OFF position and lock safety catch.

6. Proceed to the front cab.

On entering the Front Driving Cab—

1. Place Hostler control knife switch in the MAIN CONTROL position.

2. Place all switches on driver’s control panel in the ON position.

3. Insert the Brake valve handles and place the independent brake valve in SLOW APPLICATION position.

4. Open the brake valve isolating cock.

5. Insert reverser handle and proceed with normal operation.
Path of the Water

1. The PUMP drives water through the engine to cool the cylinders.

2. The RADIATORS receive this water and heat is given up to the air.

3. COOLING FANS control the amount of air through the radiators by operating in varying combinations.

4. THERMOSTATS cut the cooling fans in and out in accordance with engine temperature.

5. The LUBRICATING OIL COOLER uses the water to remove heat from the engine lubricating oil.

6. The TANK.
   —Provides a reservoir for water draining from the radiators when the engine shuts down.
   —Provides a reserve of water to make up for evaporation.
Path of the Oil

1. The PRESSURE PUMP delivers oil to the engine where it lubricates and cools the engine parts.

2. The ENGINE SUMP receives the oil when it has finished its job.

3. A STRAINER prevents particles from damaging.

4. The SCAVENGING PUMP, which delivers oil to

5. The OIL FILTER where the oil is cleaned, and

6. The OIL COOLER where the heat in the oil is given to the engine cooling water.

7. The SUCTION STRAINERS prevent particles from damaging the pressure pump which sends oil back through the system.

—Surplus oil overflows to the engine sump.
Path of the Fuel

1. The CONTROL SWITCH and FUEL PUMP CIRCUIT BREAKERS in the electrical cabinet closes the circuit to

2. The FUEL PUMP RELAYS in all locomotive units

3. When the CONTROL and FUEL PUMP CIRCUIT BREAKER in each unit is ON, the fuel pump will run.

4. The TANK where the fuel is stored supplies fuel through

5. The SUCTION FILTER to protect the pump.

6. The PUMP delivers the fuel through

7. The DISCHARGE FILTER and

8. The SINTERED BRONZE FILTER where all remaining foreign matter is removed before the fuel goes to

9. The INJECTORS. The injectors measure, time and atomise the fuel while injecting it into the cylinders.

10. The SIGHT GLASS checks the surplus fuel on the way back to the tank. This provides a visual indication of fuel flow.
Path of the Air

1. The AIR FILTER cleans the air before passing it to
2. The LOW PRESSURE CYLINDERS. The air is pumped up to about 30 lbs. pressure and discharged into
3. The INTERCOOLER. The air is cooled and discharged to
4. The HIGH PRESSURE CYLINDER where it is pumped up to approximately 120 lbs. pressure and discharged into the main reservoir.

Air Compressor Unloaded

5. When the MAIN RESERVOIR pressure reaches its maximum it unseats a piston in
6. The AIR COMPRESSOR GOVERNOR.
7. The UNLOADER LINES carry air pressure to the unloader pistons.
—The pressure on the loader pistons holds the suction valves off their seats. Even though the compressor continues its rotation, no air is compressed. The air goes in and out through the breathers.
Air System—(Cont’d.)

Main Reservoir Pressure

Pressure should be 110 to 120 lbs. —Control is automatic but can be controlled manually.

Manual Control of Air Pumping

In emergencies it may be necessary to control the loading and unloading of the compressor manually.

1. Normal Operation — The governor controls the compressor.

Cocks should be as indicated in the diagram.

2. Permanently Unloaded.

By turning the by-pass cock handle up, air from the main reservoir goes direct into the unloader line; this prevents the compressor from pumping.
Air System—(Cont’d)

3. Permanently Loaded.

By turning the governor cut off cock up, air from the main reservoir is cut off from the governor and unloader lines. The compressor will pump continuously. Pressure will go up to the safety valve limit of 150 lbs.
The load regulator is located on the right hand side of the locomotive at the rear of the equipment rack. Its function is to control automatically the loading of the engine by the main generator, so that a constant predetermined power output is obtained for each position of the throttle. The load regulator is an automatically operated rheostat connected in series with the main generator battery field. (This is a low voltage externally excited field).

The load regulator is in minimum field when the brush arm is in the four o'clock position. Maximum field is obtained when the brush arm is in the eight o'clock position.
Front of Electrical Cabinet

1. Wheel Slip Relays—(WS)—Light the cab indicator and reduce power to traction motors when wheels slip.
   Where automatic sanding is used, sanding relay is energised by the operation of the wheel slip relays.
2. Time Delay Sanding Relay —(TDS)—Initiates sand-
Electrical Controls—(Cont’d.)

1. Field Shunting Relay—(FTS)—Operates field shunting contactor (FS2) at predetermined main generator voltages to make transition from the first to second stage traction motor field shunting and back.

2. Forward Transition Relay—(FTR)—Operates at predetermined main generator voltages to operate the transition relay and field shunting contactor (FS1) during transition.

3. Transition Relay—(TR)—Controls transition from the first stage to second stage of series parallel.

4. Time Delay Relay—(FSD)—Time delay on pick up for field shunting relay.

5. Time Delay Relay—(TDO)—Time delay on drop out for forward transition relay during transition to second stage of series parallel.

6. Time Delay Relay—(TDR)—Time delay control for drop out voltage for forward transition relay during transition back to first stage of field shunting.

7. Fuel Pump Contactor—(FPC)—Emergency feature—Makes it possible for the driver to stop all fuel pumps from the cab.

8. Engine Relay—(ER)—Controls the circuit from the throttle to the governor.

9. Load Regulator Contactor—(LRC)—Reduces the load regulator resistance for fast starting.

10. Time Delay Braking—(TDD)—Time delay 6 to 10 seconds to allow Traction Motor Fields time to “die” before connecting them to the Dynamic Braking Circuit.

11. Battery Field Contactor—(BF)—Connects the main generator battery field to low voltage.

12. Shunt Field Contactor—(SF)—Connects the main generator shunt field to high voltage.

13. Battery Charging Contactor—(BC)—Connects the battery to the auxiliary generator when the engine is running—controlled by the reverse current relay.
Electrical Controls—(Cont’d.)

18. Battery Charging Ammeter—Should read zero or show some charge at all times with the engine running.

19. Reverse Current Relay—(RCR)—When current flows from the auxiliary generator towards the battery, it closes the battery charging contactor. When the current reverses, it opens the battery charging contactor.

20. Fuse Test—Lay the fuse to be tested across the brass blocks. If the fuse is good the light should shine. To test this light, turn the toggle switch ON and OFF.


23. No Volt Relay—(NVR)—Lights the alarm light and sounds the bell when there is no alternating current.

24. Control Air Pressure Regulator—Reduces main reservoir pressure for operating pneumatic electric contactors, reverser and cam switch.

25. Pneumatic Safety Control Relay—(PCR)—where fitted)—Safety control switch operates this relay—Reduces engine speed to idle.

26. Wheel Creep Relay—(WCR)—Wheel slip is anticipated and sanding relay is energised to initiate automatic sanding.

27. Shunt Field Transfer—(SFT)—Connects shunt field across traction motor output during dynamic braking.

28. Dynamic Brake Regulator—(DBR)—Regulates the shunt field excitation and therefore traction motor output during dynamic braking.

29. Brake Relay—(BR)—Completes dynamic brake control circuit.

30. Load Regulator Positioner—(LRP)—Keeps the excitation of the battery field at a value proportional to the setting of the dynamic brake selector lever.

31. Brake Warning Relay—(BWR)—Lights the brake warning light to indicate overload during dynamic braking.
1. Voltage Regulator—(VR)—Maintains the auxiliary generator output at a fixed voltage.

2. Reverser—Changes the traction motor connections to reverse the direction of locomotive movement.
Electrical Controls—(Cont'd.)

3. Power Contactors—Connect the traction motors to the main generator.

4. Starting Contactor—(GS)—Connects the battery to the main generator for turning the engine over.

5. Field Shunting Contactors—(FS1 and FS2)—Connect shunts across the traction motor field windings. The contactors are energised by FTR and FTS relays.

6. No. 1 Cam Switch or Brake Transfer Switch—(BKT)—During dynamic braking connects the leading bogie traction motor armatures to the braking grids and establishes braking fields.

Backward Transition Relay — (BTR) — (not shown) — Protects the generator by changing traction motor connections from parallel to series parallel.

No. 2 Electrical Cabinet.

1. No. 2 Cam Switch or Brake Transfer Switch — (BKT)—During dynamic braking connects the trailing bogie traction motor armatures to the braking grids and establishes braking fields.

2. Control terminal board.
X Class
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TRANSITION

Four types of traction motor electrical circuit connections are used so that full power may be obtained at all times from the main generator within its current and voltage limits.

1. Series Parallel — Stage 1 — for starting and heavy pulling.

2. Series parallel — Stage 2 — for normal running.

3. Stage 2 Series parallel with 46% shunting of motor fields — for higher speeds.

4. Stage 2 Series parallel with 74% shunting of motor fields — for still higher speeds.

The change from one type of connection to another is called transition and is effected automatically.
4. At the driver's control panel:—
   (a) Control switch must be ON.
   (b) Engine Run switch must be ON.

5. At the isolation switch panel—
   Isolation switch should be in START position.
Accessory End of Engine:

- **LOW OIL BUTTON**: PUSH IN TO RESET
- **OVERSPEED TRIP**: PULL TO RESET
- **GOVERNOR OIL LEVEL**
- **CYLINDER TEST VALVE**
- **LAYSHAFT MANUAL LEVER**: PULL TO SHUT DOWN ENGINE
- **CRANKCASE PROTECTOR**
- **LOW WATER PROTECTOR**

**FUEL MUST BE FLOWING THROUGH GLASS NEAREST ENGINE FACE ONLY.**

4. Check that the crankcase (oil pan) pressure and low water detector reset buttons are set (pressed in). If the buttons protrude, press to reset. Low water detector test cock should be in the vertical position.

5. Check the overspeed trip.
   —Pull as indicated to reset.
STARTING ENGINE

In the Cab

Press the START button and hold until the engine starts (not more than 15 seconds).

If engine will not start refer TROUBLE SHOOTING section.

In The Engine Room:

1. Check that lubricating oil is not flowing through by-pass sight glass after engine has reached operating temperature.

NOTE: If there is oil flow, the maintenance staff must be informed.
Miscellaneous Operating Instructions

A high reading of the load indicating meter is permissible when starting a train, provided care is taken to avoid wheel slip.

Wheel Slip:
Flashing of the wheel slip light located on the control stand during power application indicates that wheels are slipping.

When Wheel Slip Occurs:
—Power to traction motors is automatically interrupted.
—Power is reapplied when wheel slip stops.
—Sand is applied automatically.
—After 8 to 10 seconds sanding stops.

If Wheel Slip Light Flashes Repeatedly:
1. Reduce throttle—one or two notches.
2. Open throttle gradually.

CAUTION:
If light persists, one set of wheels may be locked due to traction motor bearing failure.

To Check:
Stop the train, then start slowly with someone on the ground to check if all wheels are rotating. If wheels are locked, notify the locomotive depot and do not attempt to move the locomotive.

Wheel Creep
—The early stage of wheel slip.
When wheel creep occurs—
Sanding automatically takes place.
When wheel creep stops—
After a time delay, sanding stops.

NOTE: There is no interruption of power to the traction motors when wheel creep occurs.
DYNAMIC BRAKE OPERATION

Dynamic Brake Principle

When dynamic brake is used electrical connections are established which change the locomotive traction motors into generators.

The power developed by the momentum of a moving locomotive drives the traction motor armatures which are geared to the axles. This power, required to rotate the "generators", is converted into an effective brake to retard the locomotive.

The power output (braking current) produced by these "generators", increases with locomotive speed or as the dynamic "braking lever" is advanced towards the maximum braking position. This braking current flows to resistor or grids where it is dissipated as heat by a motor driven cooling fan.

The cooling fan motor is operated by portion of the current from the traction motor armatures.

The dynamic brake, although similar in effect to an independent air brake application, is fully electrical and does not produce friction between brake shoes and wheels, thus avoiding heat and wear on these components.

To use the Dynamic Brake

1. The reverser lever should be positioned in the direction of locomotive movement.
2. Throttle lever must be in IDLE.
3. Independent Air Brake should be in RUNNING position.
Dynamic Brake Operation—(Cont'd)

4. Move the dynamic brake selector from 1 to the OFF position. Allow the lever to return to the centre position and then move again to B position.

This action will disengage the throttle notching feature and the throttle lever can now be used freely as a braking lever to control the dynamic brake.

5. Pause for approximately 8 seconds then after the slack is bunched advance the "throttle lever" slowly towards the "8th notch" position to obtain the desired amount of braking. It is important that dynamic braking is applied slowly and smoothly, otherwise train surging will result.

6. To release dynamic brake, return the "throttle lever" to the idle position. When the load indicating meter falls to a steady reading move the dynamic brake selector to the OFF position and then to 1 position. Contactors will then change to reconnect the circuit for powering.
Dynamic Brake Operation—(Cont’d)

Dynamic Brake Characteristics.

In dynamic brake, when the "throttle lever" is advanced beyond IDLE position, the diesel engine speed is automatically increased from IDLE, 275 RPM, to 435 RPM to increase the flow of cooling air to the traction motors.

The braking current is automatically limited to 600 amps regardless of locomotives speed or "Throttle lever" position. The actual braking current is shown on the load meter.

If the "throttle lever" is moved too quickly, the dynamic brake current will rise too rapidly and a sudden surge of over-current may result as indicated by the brake warning light. (The wheel slip light performs both functions of indicating wheel slip and over-braking).

Flashing of the brake warning light indicates an overload in the braking system.

To rectify—reduce braking by returning "throttle lever" towards IDLE until light disappears.

The brake warning light should not remain on for more than 5 seconds.

A wheel slip indication may also show during dynamic braking if slippery rail conditions are encountered.

NOTE:—Dynamic brake is most effective at about 22 m.p.h. It becomes less effective at speeds above and below this figure. Speeds on grades should not be allowed to "creep up" by careless handling of the brake for this reason.

When necessary train brakes may be used in conjunction with the dynamic brake, to reduce train speed. During such applications an interlock prevents application of the air brakes on the locomotive.
Dynamic Brake Operation—(Cont'd)

In the event of an emergency air brake application the dynamic brake is automatically released and the air brake applied on the locomotive when the brake pipe pressure is reduced below 45 p.s.i.

When an automatic service brake application is made and the dynamic brake is then operated, the dynamic brake inter-lock will release the brake application on the locomotive only. However, should the dynamic brake be released while the automatic service application is still on the train, the locomotive Westinghouse brakes will re-apply.

CAUTION: When working units in multiple, DO NOT PLACE AN ENGINE ON THE LINE WHILE USING THE DYNAMIC BRAKE.
COOLING SYSTEM

Path of the Water

1. The PUMP drives water through the engine to cool the cylinders.

2. The RADIATORS receive this water and heat is given up to the air.

3. COOLING FANS & SHUTTERS control the amount of air through the radiators.

4. THERMOSTATS cut the cooling fans and shutters in and out in accordance with engine temperature.

5. The LUBRICATING OIL COOLER uses the water to remove heat from the engine lubricating oil.

6. The TANK.
   —Provides a reservoir for water draining from the radiators when the engine shuts down.
   —Provides a reserve of water to make up for evaporation.
Cooling System — (Cont’d)

NOTE.—A low water protection device fitted to the engine, balances water pressure against air box pressure. In the event of loss of engine water pressure the device will trip causing the engine to shut down through its action on the low lube oil shut down section of the engine governor. Directions for resetting the low water protector are given in the trouble shooting section.
LUBRICATION SYSTEM

Path of the Oil:

Oil from the engine sump is drawn through the:

1. SCAVENGE OIL STRAINER by the

2. SCAVENGE PUMP which delivers oil to the

3. LUBE OIL COOLER where heat in the oil is given up to the engine cooling water before oil passes to the

4. MICHIANA FILTER where the oil is cleaned.

5. SUCTION STRAINERS prevent particles from damaging the

6. PRESSURE PUMP which delivers oil to the engine where it lubricates and cools the engine parts — Surplus oil overflows to the engine sump. A by-pass fitted with a

7. BY-PASS valve and

8. SIGHT GLASS is connected between the inlet to the lube oil cooler and the discharge side of the lube oil filter and permits circulation of cold oil or oil volume in excess of filter capacity.
Path of the Fuel:

1. The CONTROL circuit breaker and CONTROL and FUEL PUMP switch in the cab close the circuit to
2. the FUEL PUMP RELAY.
3. When the FUEL PUMP CIRCUIT BREAKER is ON, the fuel pump will run.
4. The TANK where the fuel is stored supplies fuel through
5. the SUCTION FILTER to protect
6. the PUMP, which delivers fuel through
7. VISCOSE STRING WOUND filters where all remaining foreign matter is removed before fuel goes to
8. the INJECTORS. The injectors measure, time and atomise the fuel while injecting it into the cylinders.
9. The SIGHT GLASS shows surplus fuel returning to the tank. This provides a visual indication of fuel flow.
1. Resistors—300 Ohm Field Shunt Biassing resistor and 500 Ohm Speedrecorder light adjustment.
2. 1000 M.F.D. Capacitor.
4. Resistors—300 Ohm Main Generator Shunt Field Discharge.
5. Resistors—10 Ohm Quick Start Resistors.


8. Wheel Slip Relays—WS14, WS5 and WS36—Voltage Sensitive Type—Light the cab indicator and reduce power to traction motors when wheels slip. When automatic sanding is used, sanding relay is energised by the operation of the wheel slip relays.

9. Ground Relay Isolating Switch—open circuits the ground relay for maintenance purposes.

10. Battery Field Contactor—(BF)—Connects the main generator battery field to low voltage.

11. Shunt Field Contactor—(SF)—Connects the main generator shunt field to high voltage.

12. Time Delay Sanding Relay—(TDS)—Initiates sanding automatically, for approximately 10 secs. when wheel creep or wheel slip relays operate.

13. Ground Protective Relay—(GR)—Provides protection for equipment against earthing of high voltage.

14. Fuel Pump Contactor—(FPC)—Completes the circuit from the battery to the fuel pump and makes it possible for the driver to stop fuel pumps in all units from one cab when working in multiple.

15. Forward Relay—(FOR)—Controls the low voltage circuits for locomotive operation in "forward" direction.

16. Reverse Relay—(RER)—Controls the low voltage circuits for locomotive operation in "reverse" direction.

17. Engine Run Relay—(ER)—Controls the circuit from the throttle to the governor.

18. Load Regulator Contactor—(LRC)—Reduces the load regulator resistance for fast starting.

19. Sanding Circuit Breaker—Isolates the sanding circuits.
Electrical Controls—(Cont’d.)

20. Transition Relay—(TR)—Controls transition from first stage to second stage of series-parallel.

21. Field Shunt Delay Relay—(FSD)—Time delay on pick up for field shunting contactors.

22. No Volt Relay—(NVR)—Lights the alarm light and sounds the bell when there is no alternating current being generated.

23. Fuse Test—Fuses may be tested in the following manner

(a) Switch on test light switch—fuse test light should light. Failure of this lamp to light indicates that the lamp has blown and must be replaced before continuing the test. A step light can be used as a replacement.

(b) Place switch in the OFF position.

(c) Place fuse across the brass blocks and the lamp will light if the fuse is satisfactory.

24. 400 Amp Starting Fuse.

25. Battery Knife Switch—Isolates the Batteries.


27. 30 Amp Auxiliary Generator Field Fuse.

28. 60 Amp Alternator Field Fuse.

29. 150 Amp Auxiliary Generator Fuse.

30. 80 Amp Battery Field Fuse.

31. Fuse Test Light Switch.

32. Fuse Test Light.

33. Left hand cab heater 30 amp fuse.

34. Right hand cab heater 30 amp fuse.

35. Field Shunt Relay—(FSR1)—Controls the operation of field shunting contactor FS1 at predetermined conditions of main generator current and voltage to shunt a portion of the traction motor fields.
Electrical Controls—(Cont’d.)

36. Field Shunt Relay—(FSR2)—Controls the operation of field shunting contactor FS2 at predetermined conditions of main generator current and voltage to shunt a further portion of the traction motor fields.

37. Parallel Transition Relay—(PTR)—Operates at predetermined conditions of main generator current and voltage to change traction motor connections from Series Parallel first stage to Series Parallel second stage.

38. Wheel Slip Relay—(WSS)—Current Sensitive Type—Lights the cab indicator and reduces power to traction motors when wheels slip. When automatic sanding is used, sanding relay is energised by the operation of the wheel slip relay.

39. Wheel Creep Relay—(WCR)—Anticipates wheel slip and causes sand to be applied.

40. Main Generator Shunt Field Resistor.

41. Battery Charging Resistor.
LEGEND—Electrical Cabinet Engine Room Side

1. Traction Motor Field Shunt Resistors.

2. Field Shunt Contactor—(FS1)—Connects shunts across the traction motor fields to give one stage of field weakening.

3. Field Shunt Contactor—(FS2)—Connects shunts across the traction motor fields to give a second stage of field weakening.
Electrical Controls—(Cont’d.)

4. Generator Start Contactor—(GS)—Connects the battery to the main generator for starting the diesel engine.

5. Dynamic Braking Switches, where fitted—(BKB3, BKB4)—During dynamic braking and in association with Power Switches BKP1 and BKP2 connect the traction motor armatures to the grids and establish braking fields.

6. Reverser Reverse Contactors—(RVR5, RVR36)—Connect the traction motor fields for travelling in the reverse direction.

7. Reverser Forward Contactors—(RVF14, RVF2)—Connect the traction motor fields for travelling in a forward direction.

8. Magnetic Power Switches—(BKP1 & BKP2)—Connect the traction motors to the main generator for normal locomotive operation under power.

9. Braking Contactor—(BK)—During dynamic braking completes the braking field circuit.


12. Battery Charging Rectifier—Allows charging current to flow from the auxiliary generator to the battery when the engine is running and prevents a return flow of current when the engine is stopped.

13. Load Indicating Ammeter Shunt.

14. Resistors—3x1.2 Ohm—Limits Main Generator Battery Field excitation during dynamic braking.

15. Resistors—2x10,000 Ohm. Dynamic Brake Regulator Setting.

16. Resistors—2x10,000 and 1x15,000 Ohm. Brake Warning Relay Setting.

18. Resistor—100 Ohm. In series with the load regulator —(LR)—Provides in conjunction with item 19 the correct voltage drop across Load Regulator Positioner (LRP) when LR is in minimum field to initiate a change from powering to braking.

19. Resistors—100 Ohm and 500 Ohm. Adjust the voltage drop across Load Regulator Positioner (LRP) to initiate a change from powering to braking.

20. Generator Field Relay—(GFR)—Isolates portion of the dynamic brake control circuit when powering.

21. Load Regulator Positioner—(LRP)—Acts in dynamic brake on the load regulator (LR) through the overriding solenoid in the governor to cause the LR to follow movements of the dynamic brake control lever (throttle) and thus controls main generator battery field excitation and in turn Traction Motor Field strength.

22. Capacitor 150 m.f.d.—Delays the pick up of the Brake Warning Relay.

23. Dynamic Brake Regulator—(DBR)—Limits the braking circuit to a maximum of 600 amps.

24. Brake Warning Relay—(BWR)—Illuminates the brake warning light to indicate overload during dynamic braking.

25. Shunt Field Transfer—(SFT)—Connects the main generator shunt field across traction motor output during dynamic braking.

26. Power to Brake Delay—(PBD)—Provides a delay to allow traction motor fields to “die” before connecting them to the dynamic braking circuit.

27. Brake Relay—(BR)—Completes dynamic brake control circuits.
ENGINE WILL NOT START

Engine Will Not Turn Over

Check:
1. Isolation switch — must be in START.
2. Control circuit breaker in electrical cabinet — must be ON.
3. Control switch on driver’s control panel — must be ON.
4. Main battery switch — must be CLOSED.
5. 400 amp. starting fuse.

Engine Rotates, but Will Not Fire

Check:
1. Fuel flow through sight glass.
2. Low oil pressure button on governor.
3. Overspeed trip.
4. Engine Protector reset Buttons.

If the engine starts, but stops as soon as the Isolation Switch is turned to RUN, the throttle may be in the STOP position.

Engine shut down after a short idling period may be due to the Engine Protector having been tripped prior to or during starting.

In this event, the procedure as detailed on pages 212 and 213 should be followed.
OVERSPEED TRIP

Operates at Approximately 910 RPM.

- Fuel is stopped at injectors.
- Engine cannot be started until overspeed trip is reset.
- PULL LEVER ANTI-CLOCKWISE TO RESET.
- Start engine in usual manner.

Crankcase (Oil Pan) Pressure/Low Water/Low Oil Alarm Light (Engine Protector):

A mechanism to detect low engine lubricating oil pressure or high suction is built into the engine governor. This mechanism is actuated by true oil pressure failure or by dumping oil from the engine oil line leading to the governor. In either event a small button will pop out of the governor body, indicating that the mechanism has tripped the low oil alarm switch. The amber light on the engine control panel will come on to indicate that the low oil mechanism has tripped.
Crankcase (Oil Pan) Pressure/Low Water/Low Oil Alarm Light (Engine Protector): (Cont’d)

When a Crankcase (Oil Pan) Pressure/Low Water/Low Oil alarm occurs it is necessary to determine whether the crankcase pressure-low water detector has tripped to dump engine oil from the line leading to the governor, or whether a true oil failure has occurred. This can be determined by checking the crankcase pressure-low water detecting device, for protruding reset buttons. A protruding upper button indicates excessive oil pan pressure; a protruding lower button indicates low water. (Depress buttons to reset).

Low oil pressure or high oil suction in the diesel engine lubricating system may be due to insufficient oil, excessively hot oil, diluted oil, or clogged strainers.

The diesel engine in the unit concerned will be stopped and the amber light on the engine control panel will be on. The push-button on the governor will be out, with the red indicating band exposed. The blue alternator failure light will also come on.

CORRECTION—The following steps should be taken to correct or determine cause of difficulty.

1. Isolate unit to stop alarm bells.
2. Reset governor trip button. Amber light will go out.
3. Check engine lubricating oil level using dipstick. Oil should be near FULL mark.
4. Observe for external oil leakage from broken pipes.
5. Check the low water and crankcase (oil pan) pressure detecting device mounted on the engine. If the lower button protrudes, the failure is due to low water. If the upper button protrudes, the failure is due to excessive oil pan pressure.

Upper Button Protrudes:

CAUSE—Oil pan pressure exceeds a predetermined positive pressure setting. May be the result of gases entering the oil pan through cracked pistons, badly worn rings, broken rings, or due to a dirty oil separator.
Crankcase (Oil Pan) Pressure/Low Water/Low Oil Alarm
Light (Engine Protector): (Cont’d)

EFFECT—Engine shut down.

CORRECTION—Manually reset the device, and proceed with the checks 2, 3 and 4 above. Maintenance staff should be advised if the button continues to trip when engine is restarted.

Lower Button Protrudes:

CAUSE—Low water level or sudden loss of engine water.

EFFECT—Engine shuts down. If water level is only slightly low, the engine may shut down only at high throttle positions.

CORRECTION—Manually reset the device. Check for water leaks. Add water. Reset governor low oil trip button.

NOTE:—Do not add cold water to a hot engine.

Restart engine after reset buttons have been pressed and corrective action taken. Observe oil pressure on gauge. It should be a minimum of 15 p.s.i. with engine at idle.

CAUTION:—In the event of continued low oil pressure, high suction or low water, the governor trip button will again move to stop the engine. The engine should not be repeatedly started or forced to run when the governor keeps shutting down the engine. The engine should NEVER be manually operated by using the layshaft lever to take control away from the governor when the governor persists in stopping the engine—Maintenance staff should be advised.
FUEL FLOW

Normally a good flow of fuel, clear and free from bubbles, should be indicated in the return sight glass.

If no Fuel Flow

Check:

1. Battery switch on distribution panel.
2. Control circuit breaker in electrical cabinet.
3. Fuel pump circuit breaker in electrical cabinet.
4. Control and fuel pump switch on Driver’s control panel.

If fuel pump motor is Running but Fuel is not Flowing

Check:

1. Fuel supply.
2. Leak in suction piping between tank and pump.
3. Broken or slipping coupling between motor and pump.

Fuel flowing out of stand pipe in by-pass (right hand) sight glass should be reported.
LOCOMOTIVE FAILS TO RESPOND

Engine will not Speed Up when Throttle is Opened

Check:

1. Isolation switch—must be in RUN.
2. Control and fuel pump and engine run switches on driver’s panel — must be ON.
3. Control circuit breaker in electrical cabinet — must be closed.
4. No voltage relay.
5. Ground protective relay.

Engine Speeds Up, but Locomotive will not Move when Throttle is Opened.

Check:

1. Reverser handle — must be in FORWARD or REVERSE.
2. Generator field switch on driver’s control panel — must be ON.
3. Hand brake and air brakes — must be released.
4. 80 amp. battery field fuse.
5. Local control circuit breaker must be ON.
6. Dynamic brake selector lever should be 1 position.

Engine goes to Idle

Check:

1. Ground protective relay.
2. No voltage relay.
3. Control and fuel pump and engine run switches on the driver’s control panel—must be ON.
4. Isolation switch — must be in RUN.
5. Control circuit breaker—must be ON.
Locomotive Fails to Respond—(Cont’d.)

Engine Stops

Check:

1. Throttle — may be in STOP position.
2. Control and fuel pump engine run switches on the driver’s control panel—must on ON.
3. Control circuit breaker—must be ON.
4. Fuel pump circuit breaker in electrical cabinet — must be ON.
5. No voltage relay.
7. Overspeed trip.
8. Low oil pressure button.
9. Check reset buttons on crankcase pressure-low water protector located on the accessory end of the engine beneath the manual layshaft lever. Depress to reset.

NOTE. If the fault cannot be located after following the procedures outlined above, shut the engine down completely and restart. This action may remove the cause of the trouble.
BATTERY CHARGING AMMETER

If Ammeter Shows Continuous DISCHARGE with Engine Running

Check:

1. Auxiliary generator field 30 amp. fuse in the electrical cabinet.

2. Battery charging (auxiliary generator) fuse — 150 amp.

NOTE:—A heavy discharge reading at engine stop, followed by burned out auxiliary generator fuse indicates a shorted battery charging rectifier. Battery knife switch should be opened promptly and the maintenance staff advised.
ALARMS

The alarm bell is situated on the side of the driver's control stand.

When a fault exists in multiple unit working the alarm bell rings in all units, the light shines ONLY in the faulty unit.

Alarm Lights

On the driver's control panel —

Red Light—Ground Protective Relay

Main generator earthed.

Engine will return to IDLE or will STOP if throttle is in notch 5 or 6, alarm bell will ring and ground relay light will shine. If the engine stops, blue light will also shine.

1. Isolate engine and reset ground protective relay by pushing reset button on driver's control panel.
2. Put engine "on the line" and if relay continues to trip do not use power in this unit.

Red Light—Hot Engine Alarm

Alarm bell will ring and red light will shine if engine water temperature is over 208 deg. F. at outlet.

—Isolate engine and investigate cause.
—Check water level in sight glass.
Alarms—(Cont’d.)

—Bell will stop and light will go out when engine water temperature drops to 195 deg. F.

NOTE: Engine control is not interrupted in the case of a hot engine alarm.

Red Light—Brake Warning and Wheel Slip

If light flashes repeatedly move the throttle handle towards idle position until the condition is rectified.

Amber Light—Low Oil Pressure, High Oil Suction, Crankcase Pressure or Low Water

Low oil pressure button on governor moves out and coloured band appears.

Alarm bell will ring and engine will shut down. Blue light will also shine.

1. Isolate engine and reset low oil pressure button on governor.
2. Check and reset engine protector buttons (if necessary).
3. Check oil level and oil leakage from broken pipes.
4. Check water level in sight glass.
5. Start engine and observe oil pressure.

—If fault still exists engine will shut down after approximately 40 seconds running at idle speed.

—If an attempt is made to run above idle speed during the delay period, then engine will stop immediately.

DO NOT REPEATEDLY START ENGINE IF THE LOW OIL BUTTON KEEPS SHUTTING ENGINE DOWN.
Alarms—(Cont’d.)

Blue Light—Alternator Failure

Designed to indicate “No Voltage” on the alternator.

Due to alternator being stopped, light will shine and alarm bell will ring whenever the engine stops while “on the line.”

Turn isolation switch to START.

Check:

1. Overspeed trip.
2. Oil pressure button on governor.
3. Engine Protector buttons.
4. Fuel flow.
5. Start engine and put “on the line.”

If light comes on instantly or shines with engine running, the no voltage relay may be open.

If N.V.R. opens the engine will go to IDLE or will STOP if throttle is in notch 5 or 6.

Check:

1. Auxiliary generator field 30 amp. fuse.
2. Alternator field 60 amp. fuse.
3. Battery charging (auxiliary generator) 150 amp. fuse.
<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (fully loaded) with no modification</td>
<td>114 tons</td>
</tr>
<tr>
<td>Starting Tractive Effort (25% adhesion)</td>
<td>63,500 lbs.</td>
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<tr>
<td>Continuous Tractive Effort</td>
<td>Unlimited</td>
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<tr>
<td>Gear Ratio</td>
<td>59:18</td>
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<tr>
<td>Maximum Permissible Speed</td>
<td>83 m.p.h.</td>
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<tr>
<td>Number of Drivers</td>
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<tr>
<td>Weight on Drivers</td>
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<tr>
<td>Wheel Diameter</td>
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<tr>
<td>Fuel Oil</td>
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<tr>
<td>Lubricating Oil</td>
<td>165 gallons</td>
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<tr>
<td>Cooling Water</td>
<td>175 gallons</td>
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<tr>
<td>Sand</td>
<td>16 cu. ft.</td>
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<tr>
<td>Bogie Centres</td>
<td>33’ 0”</td>
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<tr>
<td>Bogie Rigid Wheel Base</td>
<td>13’ 3”</td>
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<tr>
<td>Minimum Curve Radius</td>
<td>274 feet</td>
</tr>
<tr>
<td>Length over Buffers</td>
<td>60’ 3”</td>
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<tr>
<td>Height above Rail Level</td>
<td>14’ 0”</td>
</tr>
<tr>
<td>Width Overall</td>
<td>9’ 8”</td>
</tr>
<tr>
<td>Track Gauge</td>
<td>4’ 8½”, 5’ 3”</td>
</tr>
<tr>
<td>Air Reservoirs</td>
<td>27 cu. ft.</td>
</tr>
</tbody>
</table>
X Class

37 - 44
TRANSITION:

Five types of traction motor electrical circuit connections are used so that full power may be obtained at all times from the main generator within its current and voltage limits.

1. **Series Parallel—Stage 1**—for starting and heavy pulling.
   Two parallel groups of three motors in series.

2. **Series Parallel—Stage 2**—for normal running.
   Three parallel groups of two motors in series.

3. **Stage 2 Series Parallel with 55% shunting of motor fields** —for increased speeds.

4. **Stage 2 Series Parallel with 64% shunting of motor fields** —for higher speeds.

5. **Stage 2 Series Parallel with 74% shunting of motor fields** —for higher speeds.
STARTING AND STOPPING ENGINES

Perform the following:

1. Place the fuel prime/engine start switch in the FUEL PRIME position and hold until the return fuel sight glass (nearest to the engine) is full and clear. This primes the system and purges air from the fuel.

   If there is any flow of fuel through the adjacent (right-hand) glass, the maintenance staff must be notified.

2. Position the layshaft lever at about one third rack then move the fuel prime/engine start switch to ENGINE START position. Release the fuel prime/engine start switch and layshaft as soon as engine speed increases and governor control of the linkage is felt at the lever.

   Do not over rev the engine.

   Do not crank the engine for more than 20 seconds to turn an engine over.

   If the engine does not start after 20 seconds of free cranking, release the starting switch. Allow a brief period to elapse between cranking attempts.

   **NOTE:** When the fuel prime/engine start switch is released ensure that the switch returns to the normal run (vertical) position.

3. Immediately after engine starts check that the crankcase (oil pan) pressure and low water detector reset buttons are set (pressed in). If the buttons protrude, press and hold for 5 seconds.

   The low water detector will often trip during engine starting, especially when the engine is cold or when the water tank pressure cap has been removed to add water. The detector should be reset as soon as the engine starts and is idling, or else the engine will shut down after a time delay established by the governor. Check the low water reset pushbutton after every engine start.

   **NOTE:** The reset buttons on some detectors will not latch in when the engine is shut down. If such a condition is encountered, reset the device after engine starts.
STARTING AND STOPPING ENGINES

STOPPING ENGINE

There are five ways to stop the engine.

1. Press the engine stop button on the engine control panel.

   This is the normal method adopted.

   When the locomotive is standing still the isolation switch should be placed in START position. The stop button can then be pressed in to stop the engine. Since the action of the stop button is instantaneous, it need not be held in.

2. Use layshaft lever.

   The layshaft lever at the accessory end of the engine can be operated to override the engine governor and move the injector racks to the no fuel position.

3. Open the low water detector test cock.

   When the low water detector trips, oil is dumped from the governor low oil shutdown device, stopping the engine.

4. Use throttle lever.

   To stop all engines “on the line” in a consist, simultaneously from the cab of the lead unit, move the throttle to the IDLE position, pull the lever out and away from the controller, and move it beyond IDLE to the STOP position.

5. Pull out low oil shutdown button on the governor.

   NOTE: Observe freezing weather precautions whenever an engine is shut down during cold weather.

SECURING LOCOMOTIVE FOR LAYOVER

1. Place the reverse lever in neutral position and the throttle in IDLE.

2. Place the selector lever in the OFF position and remove the reverse lever from controller.

3. Place isolation switch in START and press stop button IN.

4. Place all switches on the control stand in the OFF position (down).
STARTING AND STOPPING ENGINES

5. Place all circuit breakers and switches on the circuit breaker panel and the engine control panel in the OFF position and open all knife switches.

6. Apply hand brake on walkway and block wheels, if necessary.

7. Cover engine exhaust stacks if there is danger of severe rain.

8. Protect engine if there is danger of freezing.

SAFETY PRECAUTIONS

To Kill High Voltage

Turn isolation switch to START.

To Kill Low Voltage

1. Stop the diesel engine.

2. Open battery knife switch on the Fuse and Switch Panel.

To Prevent Starting of Engine

To work safely without the danger of someone accidentally starting the engine:

1. Remove the 400 amp. starting fuse on the Fuse and Switch Panel.

2. Place “DO NOT START” notice adjacent to the engine start controls in the engine room.

To Prevent Movement of Locomotive while Engine is Running

Before leaving the locomotive unattended:

1. Move the selector lever to the OFF position.

2. Place the Independent air brake in full application position.

3. Apply hand brake

4. Remove the reverse handle.

5. Place generator field switch in OFF position.

6. Place Isolation Switch in START position.
HUMP CONTROL OPERATION

The Hump Control switch on the driver’s control stand completes the circuit to introduce this phase of locomotive operation.

This switch should be placed in the ON (up) position when Hump Control operation is required. This action causes the Hump Control Indicator light on the control stand to shine.

When operative Hump Control provides a finer graduated control of locomotive power than that normally obtained by throttle operation.

Following selection of Hump Control operation the control rheostat can then be used, as required, to reduce the power level, as set by each throttle position, to suit the particular demands of the required operation.

Full locomotive power appropriate to the throttle setting selected is available when the rheostat is turned to the full extremity of travel in the INCREASE direction.

Hump Control operation is particularly useful for making fine adjustments in power to control wheel slip, either during ascent of a grade or starting a train, when adverse adhesion conditions are encountered.

It also provides a means of slow speed train control.

Hump Control operation in throttle position 8 allows full traction motor and main generator cooling air supply to be maintained.

All units of a multiple consist can be operated at a reduced power setting from the leading unit when Hump Control is selected on this locomotive.
TRACTION MOTOR CUTOUT SWITCH

The cutout switch cannot be turned unless the unit is isolated and the local control circuit breaker is closed.

Traction Motor Failure

If traction motor failure is suspected after repeated ground relay operation, proceed as follows:

1. Stop the locomotive.

2. Turn isolation switch to START and reset the ground relay.

3. Inspect traction motors for any obvious indications as to which motor is faulty (e.g., overheating, presence of smoke, etc.).

4. If no fault is apparent, isolate the traction motors by turning the MOTOR CUTOUT SWITCH to positions 1-4, 2-5, 3-6 in sequence and apply power in each position until the faulty motor is located.

5. Check that the armatures of any motors that have been cut out are free to rotate by observing from the ground that wheels do not skid when the locomotive is moved.

NOTE: Motors are isolated in pairs, i.e., with motor cutout switch in 1-4 position motors 1 and 4 are isolated. With motor cutout switch in 2-5 position motors 2 and 5 are isolated. With motor cutout switch in 3-6 position motors 3 and 6 are cut out.

Motors are numbered from 1 to 6 commencing at the short hood end of the locomotive.

With a pair of motors isolated the locomotive should be operated with reduced loading, conforming to Departmental Instructions.

It should be noted that if motors 2 and 5 are isolated, no current will be shown on the load indicating ammeter.

MOTOR CUTOUT SWITCH MUST NOT BE OPERATED WHEN POWER IS BEING APPLIED.

NOTE: Dynamic brakes become inoperative when any pair of motors are cut out.
TROUBLE SHOOTING

INTRODUCTION

This section is devoted to operational problems that may be encountered on the road and the steps that can be taken to determine their cause and to make necessary corrections. No attempt is made to provide detailed explanations of the equipment functions concerned.

Troubles occurring on the road and the resulting delays can be minimised through proper locomotive inspection, maintenance and operation. When operating problems do occur, however, it is important that they be quickly eliminated. Towards that end, a good, thorough understanding of locomotive equipment function is helpful. This basic knowledge, together with the suggestions given in this section should provide the necessary means for achieving the “on time” performance desired.

General Procedure

Safety devices automatically protect the equipment in case of faulty operation of almost any component. In general this protection is obtained by unloading or preventing the loading of the diesel engine, with a resulting loss of locomotive pulling power. In most instances, the diesel engine speed will be reduced to idle.

Operating difficulties are usually indicated by the ringing of an alarm bell and the lighting of one or more signal lights. The alarm circuit is arranged so that the bells will ring in all units of a multiple unit consist, but the signal light will be on only in the unit experiencing the trouble. With this arrangement the unit in trouble can be quickly detected.

Alarm Bell Rings—no Signal Lights on in Lead Unit

Cause—Fault in trailing unit

Effect—1. Lead unit engine operates at normal speed, but loss of power is evident. Cause of alarm is in trailing unit(s) and may be one of the following:

a. Ground Relay—Red. Ground Relay light will shine, engine speed will reduce to idle, and power is lost in the defective unit only. Refer “Alarm Signal Lights” in this Section for correction.
TROUBLE SHOOTING

b. D14 Alternator Failure—Blue. Alternator Failure Light will shine (no volt relay NVR dropped out) engine speed will be reduced to idle.

Refer “Alarm Signal Lights” in this Section for correction.

c. Engine Shuts Down—Blue. Alternator Failure light will shine. (No volt relay NVR dropped out.) Refer “Alarm Signal Lights” in this Section for correction.

2. Lead unit engine operating normally and no loss of power evident. Trailing unit Hot Engine—Red.

Hot Engine light will shine in defective unit. Engine speed and power will remain normal in all units. Refer Alarm Signal Lights in this Section.

Correction—1. If lead unit is operating normally, but loss of power is evident, it may be necessary to stop the train, when convenient, and examine the trailing unit(s). If ground relay is indicated then press ground relay reset button. It is desirable to isolate units or return throttle to idle before pressing reset pushbutton.

If the alarm is silenced, a trailing unit ground has been reset.

NOTE: It is advisable to reset a tripped ground relay two times. If a third trip occurs, isolate the affected unit.

If relay reset with a remote reset button does not silence the alarm, the cause of the fault must be determined in the affected unit.

2. Cause of trailing unit hot engine must be determined in affected unit. Refer Hot Engine Alarm in this Section.

NOTE: A multiple unit consist may be operated from an isolated lead unit. (Isolation Switch in START.)

ALARM SIGNAL LIGHTS

Coloured alarm signal lights are located on the locomotive control stand.

Red—Ground Relay

Cause—Tripped ground relay due to high voltage ground. May be due to insulation failure, presence of water, or an arc in the high voltage
TROUBLE SHOOTING

circuits. A low voltage ground when starting diesel engine, may also trip the ground relay.

Effect—If ground relay trips during operation engine speed will be reduced to idle, and the alarm bell will ring. No power will be developed due to generator excitation contactors being opened.

If ground relay trips when starting the engine, the engine will remain idling and will not respond to throttle changes. Also no power will be developed.

Correction—Press the ground reset button on the control stand. The light will go out, the bell will stop, power will be smoothly restored and engine speed will return to that called for by throttle position on the lead unit.

No action should be taken to cancel a small enunciator light on the Ground Detection Light Relay (GDL) in the electrical cabinet. This light should be reset by maintenance personnel only.

WARNING: When the alarm rings for the third time after using the ground reset button twice, the affected unit should be isolated.

Red—Hot Engine

Cause—Excessive engine cooling water temperature.

Effect—Alarm bell rings in all units. Engine speed and power remain normal.

Correction—To silence the alarms and extinguish the light, it will be necessary to reduce engine cooling water temperature.

1. Isolate unit and allow engine to run at idle.
2. Check water tank to see if there is sufficient water in system.
   Water level—should be at RUNNING FULL mark.
   If water is not visible in the sight glass the engine should be shut down.
3. Check to see if cooling fans are running.
TROUBLE SHOOTING

4. Check that radiator shutters are open. If closed, check position of shutoff valve in air supply line, located on radiator bulkhead above the load regulator.

NOTE: If necessary, due to failure of the shutter air operating mechanism, the shutters can be manually operated and latched open at the operating air cylinder, by engaging the locking pin provided, in the cylinder to shutters connecting linkage.

Red—Brake Warning and Wheel Slip

—Brake Warning

Cause—Excessive dynamic braking current.

Effect—Braking current is reduced automatically. Equipment damage is possible (excessive braking current) if light is allowed to cycle on and off longer than three seconds.

Correction—Excess braking current is usually quickly and automatically corrected by the dynamic brake regulator. In the event the warning light blinks excessively, the throttle should be moved to reduce braking strength. The light should never be allowed to blink on and off more than three seconds.

—Wheel Slip

Cause—True wheel slip of one second duration causes the wheel slip light to come on. Wheel creep does not cause the light to come on.

Effect—Wheel slip brings about a brief, minor reduction of power and if auto sand circuit breaker is ON a timed application of sand to the rail. Prolonged wheel slip brings about a greater reduction of power and a timed application of sand.

Correction—Corrective action is automatic. Power should be reduced only if severe lurching threatens to break the train. Full power is reapplied gradually when wheel slip stops.

WARNING: A unit experiencing repeated and persistent wheel slip action should not be isolated and allowed to remain in the locomotive consist unless inspection reveals that all wheels are capable of rotating freely.
TROUBLE SHOOTING

Amber—Engine Protector—Low Oil/Low Water/Crankcase Pressure

Cause—Low oil pressure or high oil suction in the diesel engine lubricating system. May be due to insufficient oil, excessively hot oil, diluted oil, or clogged strainers or incorrectly seated oil strainer gasket.

A low oil pressure indication is also given when the crankcase pressure/low water detecting device is tripped. This is because the device dumps oil from the low oil pressure detector in the engine governor.

Effect—The diesel engine in the unit concerned will be stopped and the amber light on the engine control stand will be on. The push-button on the governor will be out, with the red indicating band exposed. The blue ALTERNATOR FAILURE light will also come on as NVR drops out due to no D14 voltage. The alarm bell will ring.

Correction—The following steps should be taken to correct or determine cause of difficulty.

1. Isolate unit.
2. Reset governor trip button. Amber engine protector light will go out and alarm bell will stop ringing.
3. Check engine lubricating oil level using dipstick. Oil should be approximately three inches above the FULL mark when engine is stopped. (After allowing a "drain back" period.)
4. Observe for external oil leakage from broken pipes.
5. Check the low water and crankcase (oil pan) pressure detecting device mounted on the engine. If the lower button protrudes, the failure is due to low water. If the upper button protrudes, the failure is due to excessive oil pan pressure.

Upper Button Protrudes

Cause—Oil pan pressure exceeds a predetermined positive pressure setting. May be the result of gases entering the oil pan through cracked pistons, badly worn rings, broken rings, or due to a dirty oil separator.
TROUBLE SHOOTING

Effect—Engine shut down.

Correction—Reset governor low oil trip plunger. Manually reset the detector device by holding the button in for 5 seconds. Proceed with the checks shown for low oil shutdown. Check also for excessive white fumes from engine at top deck covers.

It is not recommended that the upper button (crankcase pressure) be reset more than once unless it is apparent that the latching mechanism is defective.

Lower Button Protrudes

Cause—Low water level, sudden loss of engine water, or low water pressure at engine start.

Effect—Engine shuts down. If water level is only slightly low, the engine may shut down only at high throttle positions.

Correction—Check for water leaks. Add water. Reset governor low oil trip plunger. Press detector reset button and hold for 5 seconds immediately after restarting engine.

6. Check that lubricating oil viscosity is not reduced due to dilution with fuel oil.

7. Check that oil viscosity is not reduced due to excessive heat. In such case the hot engine alarm may also be activated.

8. Restart engine after reset buttons have been pressed and corrective action taken. Observe oil pressure on gauge. It should be a minimum of 4 p.s.i. with engine at idle.

—If fault still exists, engine will shut down after approximately 50 seconds running at idle speed.

—If an attempt is made to run the engine above idle speed during the delay period engine will shut down immediately.

CAUTION: In the event of continued low oil pressure, high suction or low water, the governor trip button will again move to stop the engine. The engine should not be repeatedly started or forced to run when the governor keeps shutting down the engine. The engine should NEVER be manually operated by
TROUBLE SHOOTING

using the layshaft lever to take control away from the governor when the governor persists in stopping the engine.

Blue—Alternator Failure

Cause—D14 alternator failure; thus, no A.C. auxiliary power is being generated. NVR drops out. May be due to loss of D14 alternator excitation or electrical difficulty in the system (true failure). May also be caused by the diesel engine stopping for any reason while on the line (false failure).

Effect—Alarm bells ring in all units. If the false failure was due to electrical fault, the engine in the unit concerned will go to idle speed.

Correction—To silence alarms, isolate unit. Method of correction depends upon whether failure was due to electrical or mechanical fault.

A. Engine Stopped (not true D14 failure).
   1. Engine overspeed device tripped. Check lever position, reset if necessary.
   2. Low water or crankcase (oil pan) pressure detector tripped. The engine protector light will also be on in this case.
   3. Engine starving for fuel. Observe for proper fuel flow through return sight glass by operating fuel pump. If fuel is not evident, check reasons given in this section under “Insufficient Fuel”.
   4. Throttle lever in STOP position.
   5. Low oil pressure. Engine protector light will be on in this case.
   6. FPC (fuel pump contactor) de-energised (engine stops immediately). May be due to Local Control Circuit Breaker having tripped.

B. D14 Failure (engine idling).
   1. Blown 60-ampere alternator field fuse.
   2. Blown 150-ampere auxiliary generator fuse.
TROUBLE SHOOTING

CORRECTION OF OPERATING DIFFICULTIES

Insufficient Fuel

Insufficient fuel will cause erratic engine operation. Lack of fuel will cause engine to shut down. It will also prevent an engine from being started.

Condition of the fuel system may be determined by observing the two sight glasses mounted on top of the filter assembly located at the governor end of the engine. The glass closest to the engine should be full whenever the fuel pump and engine are running. The other adjacent glass should always be empty.

Fuel flowing through the by-pass (right-hand) sight glass should be reported to Maintenance authorities.

FOR FUEL PUMP TO OPERATE

1. Main battery switch must be closed.
2. Control and local control circuit breakers must be ON.
3. Control and fuel pump switch must be ON.
4. Fuel pump 15-ampere circuit breaker must be ON.
5. Auxiliary Generator fuses must be good and installed.
6. FPC and FPR coils must be energised.
7. Auxiliary generator must be developing power.
8. Fuel Prime/Engine Start Switch must be in good condition.

NO FUEL WITH PUMP RUNNING

1. Lack of fuel in tank.
2. Slipping or broken coupling between motor and fuel pump.
4. Clogged suction or discharge filters.
5. Michiana Fuel Filter drain line valve open.
TROUBLE SHOOTING

ENGINE CANNOT BE STARTED

Engine starting difficulties fall into two categories; namely, engine does not rotate in START position, or engine rotates but does not fire. The following items should be checked in either event.

Engine Does Not Rotate

1. Main battery switch must be closed.
2. Isolation switch must be in START position.
3. Starting 400-ampere fuse must be good and in place.
4. Control and local control circuit breakers must be closed.
5. Control and fuel pump switch must be in ON position (up).
6. GS contactor must pick up.
7. Engine must not contain hydraulically locked cylinder. Always report stalled cranking attempts to proper maintenance personnel.

Engine Rotates But Does Not Fire

1. Engine overspeed trip lever must be set.
2. Low oil pressure button in governor must be in.
3. Fuel system must be sufficiently primed, and layshaft lever must be positioned at about 1/3 rack.
4. Local control circuit breaker must be in ON position.
5. Governor shutdown solenoid DV must be de-energised.

ENGINE STOPS SOON AFTER STARTING

1. Fuel pump circuit breaker must remain closed.
2. Control and local control circuit breakers must remain closed.
3. Control and fuel pump switch must remain ON.
4. Low water and crankcase (oil pan) pressure detector buttons must be set. Also low oil pressure button on governor.
TROUBLE SHOOTING

5. If the engine stops when the isolation switch is turned to RUN the throttle may be in STOP position.

6. Governor oil level—oil level should be between the marks on the sight glass.

ENGINE DOES NOT RESPOND TO THROTTLE

In instances where an engine is running normally at idle speed but does not speed up when throttle is advanced, the indication is that the governor speed control solenoids AV, BV and CV are not receiving power. Generally, this condition would be due to the ER relay being de-energised. The following items should be checked:

1. Ground relay must be set.
2. NVR must be energised.
3. Isolation switch must be in RUN.
4. Engine run switch must be ON.
5. Control circuit breaker and control and fuel pump switch must be in ON position. In addition to lack of throttle response with these devices OFF, the engine will, in a few minutes, shut down from lack of fuel.

LOCOMOTIVE DOES NOT LOAD UP

In instances where the diesel engine is running and responds properly to throttle but the locomotive does not load up, the following points should be checked:

1. Reverse lever must be in either forward or reverse and reversing contactors that are energised (picked up) must correspond to the directional handle position, when the throttle is opened.
2. Selector lever must be in power No. 1 position.
3. Generator field switch must be ON.
4. 80-amp Battery field fuse must be good and in place.
5. Power contactors must pick up.
TROUBLE SHOOTING

6. Generator Battery and Shunt field contactors must pick up and over-riding solenoid must remain de-energised.

7. Brake warning light must not come on when selector lever is placed in brake position.

8. Backward Transition must function properly.

9. The Power Knock-Out Switch (PKS) must be picked up. (Main Reservoirs charged.)

The Pneumatic Control Relay (PCR) will be de-energised when PKS is dropped out. This will prevent pick up of the main generator excitation contactors BF and SF.

PCR will reset automatically if PKS is picked up and the throttle is placed in IDLE.

10. Hump Control switch on control stand must be OFF.

If switch is ON (up) but indicator light is not illuminated (due to globe failure), the Hump Control rheostat should be operated in the INCREASE direction (clockwise) to obtain power.

NOTE: If the remote traction motor cutout switch is in 2-5 position no reading will show on the load meter.

ENGINE RETURNS TO IDLE DURING OPERATION.

See possible causes in preceding article entitled "Engine Does Not Respond To Throttle".

NOTE: Control circuit breaker may be tripped. The trigger will be in mid position. To reset, move the trigger all the way to OFF, then move to ON.

ENGINE STOPS DURING OPERATION

In instances where a diesel engine stops during normal operation, the following items may be responsible:

1. Throttle may be in STOP position.

2. Engine overspeed trip may have occurred.
TROUBLE SHOOTING

3. Low oil button on governor may be out.
4. Crankcase (oil pan) pressure/low water detector tripped.
5. Insufficient or lack of fuel. See preceding fuel system difficulties.
6. Auxiliary generator 150 amp. fuse may have opened.
7. Auxiliary generator 30-amp. fuse may have opened.
8. FPC de-energised. Local Control circuit breaker tripped.
9. Control circuit breaker may be tripped. FPR de-energised

NOTE: If the fault cannot be located after checking the above steps recommence the starting procedure as outlined on pages 27–29 inclusive.

BATTERY CHARGING METER SHOWS DISCHARGE

With the diesel engine running, the auxiliary generator should provide all low voltage current needs. The battery charging ammeter should read either zero or charge. If it continually reads discharge, the following should be checked:

1. Auxiliary generator 150 ampere fuse must be good and in place.

NOTE: A strong discharge reading at engine stop, followed by a burned out auxiliary generator fuse, indicates a shorted battery charging rectifier.

2. Auxiliary generator field (30-ampere) fuse must be good and in place.

3. Voltage regulator must be operative and properly adjusted.

NOTE: In the case of 1 and 2 above engine will eventually stop due to lack of fuel.

If testing shows the fuses to be satisfactory and a continuous discharge is still apparent the maintenance staff should be notified.
TROUBLE SHOOTING

UNUSUAL OPERATING PROBLEMS

In the majority of instances, the various safety devices will function in the event of trouble to safeguard the equipment by unloading the engine, or causing it to go to idle or stop. There are instances however, when such action is not automatically taken and it may be advisable to take manual action. Since these occasions are unusual, each should be handled individually, using good judgement. The following suggestions may be helpful.

Mechanical Problems

1. Smoke Coming Out Of Exhaust—Operation may continue.

2. Oil or Fire Coming Out of Exhaust—Stop engine.

3. Smoke In Engine Room Coming From Engine—Stop engine. DO NOT REMOVE ANY INSPECTION COVERS.

4. Governor Low Oil Button Trips Repeatedly—This may be due to low oil, positive crankcase pressure, or low water pressure. If the shutdown is due to low oil or positive crankcase pressure refer to “Alarm Signal Lights” (Engine Protector) in this section. If shutdown is due to low water, it may be possible to operate the engine at reduced throttle if the low water reset button on the crankcase pressure/low water detector stays in when pressed after engine is restarted.

5. Unusual Noises—Investigate source. Stop engine or discontinue operation to prevent damage if noise is pronounced.

6. Engine Cylinder Test Valve Leaking—Do not allow engine to operate with leaking or blowing test valves.

7. Safety Valves Popping On Air Compressor Intercooler Or Main Reservoir—Continue operation:

8. Engine Overspeed Trip Stops Engine Repeatedly—Operate in reduced throttle notches where possible.

Overspeed Operates at approximately 1,000 R.P.M.
—Fuel is stopped at injectors.
—Engine cannot be started until overspeed trip is reset.
PULL LEVER ANTI-CLOCKWISE TO RESET. Start the engine in the usual manner.

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TROUBLE SHOOTING

Electrical Problems

1. Ground Relay Tripped Light Comes On Repeatedly—Isolate unit after three indications. Stop locomotive and check to see that all wheels can rotate freely.

2. Continued Wheel Slip Indication—Isolate unit; Stop locomotive and check to see that all wheels can rotate freely.

3. Loss of power is evident, but no alarm indication is given and the reason for the difficulty can not be determined. Operation may continue, but the condition should be reported to proper maintenance authority.
RESISTOR MOTOR FIELD SHUNT A

RESISTOR SHUNT FIELD TOP

RESISTOR BATT. FIELD BOTTOM

RESISTOR MOTOR FIELD SHUNT B

RESISTOR

BATTERY CHARGING

RECTIFIER

CA20 CA21

CR27 CR28

RESISTOR PANEL

R2 R14 R8 R56 R3 R4 R16 R17 R7 R6 R5

ELECTRICAL CABINET - ENGINE ROOM SIDE

247
ELECTRICAL CABINET – ENGINE ROOM SIDE

Top of Cabinet
Resistors
B.C. Battery Charging Rectifier

Bottom of Cabinet
B.56 Brake Transfer Switches
B.45 Brake Power Contactor
F.S.1 Field Shunt Contactor
F.S.2
S.45 Series Contactors (Power)
S.23
P.14 Parallel Contactors (Power)
P.25
P.36
R.V.R.5
R.V.R.36 Forward and Reverser Switches
R.V.F.14
R.V.F.2
M.12 Motor Power Switches
M.23
G.5 Starting Contactor (Engine)
ELECTRICAL CABINET - DRIVERS CAB SIDE
### ELECTRICAL CABINET — CAB SIDE

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>C.R.</td>
<td>Rectifier</td>
</tr>
<tr>
<td>D.B.R.</td>
<td>Dynamic Brake Regulator</td>
</tr>
<tr>
<td>S.F.T.</td>
<td>Shunt Field Transfer</td>
</tr>
<tr>
<td>B.W.R.</td>
<td>Brake Warning Relay</td>
</tr>
<tr>
<td>B.F.A.</td>
<td>Battery Field Auxiliary</td>
</tr>
<tr>
<td>B.R.A.</td>
<td>Brake Auxiliary</td>
</tr>
<tr>
<td>L.R.P.</td>
<td>Load Regulator Positioner</td>
</tr>
<tr>
<td>B.R.</td>
<td>Brake Relay</td>
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<tr>
<td>W.S.14</td>
<td>Wheel Slip Relays</td>
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<td>W.S.25</td>
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<td>W.S.36</td>
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<td>W.S.</td>
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<td>T.D.S.</td>
<td>Time Delay S Satung Relay</td>
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<tr>
<td>F.S.D.</td>
<td>Field Shunt Delay</td>
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<tr>
<td>T.D.F.</td>
<td>Gen. Field Time Delay</td>
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<tr>
<td>P.B.D.</td>
<td>Power to Brake Delay</td>
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<td>N.V.R.</td>
<td>No Volt Relay (A.C.)</td>
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<td>H.C.R.</td>
<td>Hump Control Relay</td>
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<tr>
<td>H.R.</td>
<td>Humping Relay</td>
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<td>G.D.L.</td>
<td>Ground Detection Light Relay</td>
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<tr>
<td>P.C.R.</td>
<td>Pneumatic Control Relay</td>
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<tr>
<td>F.P.R.</td>
<td>Fuel Pump Relay</td>
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<tr>
<td>F.O.R.</td>
<td>Forward Relay</td>
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<tr>
<td>R.E.R.</td>
<td>Reverse Relay</td>
</tr>
<tr>
<td>V.R.</td>
<td>Voltage Regulator (Aux Gen)</td>
</tr>
<tr>
<td>P.R.</td>
<td>Parallel Relay</td>
</tr>
<tr>
<td>G.R.</td>
<td>Ground Relay</td>
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B.F. Battery Field Contactor
G.F.R. Generator Field Relay
E.R. Engine Relay
F.P.C. Fuel Pump Contactor
S.F. Shunt Field Contactor
C.O.R. Cut Out Relay (Motors)
S.C.C. Short Circuited Contactor
B.V.R. Governor B. Valve Relay
A.V.R. Governor A. Valve Relay
C.V.R. Governor C. Valve Relay
X Class
45 – 54
SWITCH AND FUSE PANEL

This panel is located within the electrical cabinet that forms the rear wall of the locomotive cab. Its position is directly below the engine control panel which is located in the upper right hand corner of the electrical cabinet.

D14 Alternator Field 60-ampere Fuse

The D14 alternator receives its excitation through a pair of slip rings connected to the low voltage DC auxiliary generator output. To protect these windings, a 60-ampere fuse is provided in the excitation circuit. This fuse must be good and in place at all times during locomotive operation.

In the event that the fuse is blown, D14 alternator excitation and resulting power output will cease, giving an alternator failure light, alarm bell, and reduce the engine speed to idle.

Vigilance 6-ampere Fuse

This fuse protects the vigilance unit, acknowledgment and warning circuits. The fuse must be IN for the vigilance unit to be operative.

Ground Relay Cutout Switch

The purpose of the ground relay cutout switch is to eliminate the ground protective relay from the locomotive circuits during certain shop maintenance inspections. It MUST ALWAYS BE KEPT CLOSED in normal operation, otherwise the protection offered by the ground relay will be nullified and possible serious equipment damage could occur. It may be opened, however, in the event of extreme emergency upon receipt of definite instruction to that effect from a responsible officer of the railroad.

Fuse Test Equipment

To facilitate the testing of fuses, a pair of fuse test blocks, a test light and a test light toggle switch are installed on the fuse panel. Fuses may be readily tested as follows. First, move the toggle switch to the ON position to make sure the fuse test light is not burned out. Extinguish the light by moving the toggle switch to the OFF position. Place a fuse across the test blocks so that the metal ends of the fuse are in firm contact with the
blocks. If the fuse is good, the light will come on. If the fuse is burned out, the light will not come on and a new fuse is required. It is always advisable to test fuses before installing them in their circuits. Always isolate the circuits in question by opening their switches before changing or replacing fuses.
**Auxiliary Generator Fuse**

This fuse connects the auxiliary generator to the low voltage system. It protects against excessive current demands. A 150 ampere fuse is installed for the auxiliary generator. In the event that the fuse is burned out, it stops auxiliary generator output to the low voltage system and also stops fuel pump operation. An alternator failure (no power) alarm would then occur. The engine will go to idle speed and finally stop from lack of fuel.

**Starting 400-ampere Fuse**

The starting fuse is in use only during the period that the diesel engine is actually being started. At this time, battery current flows through the fuse and starting contactor to the cranking motors.

Although this fuse should be in good condition and always left in place, it has no effect on locomotive operation other than for engine starting. A defective fuse can be detected when attempting to start the engine, since at that time (even though the starting contactors close) the cranking circuit is open.

**Main Battery Knife Switch**

The large double-pole single-throw knife switch at the lower portion of the fuse panel is the main battery switch. It is used to connect the battery to the locomotive low voltage system and should be kept closed at all times during operation.

This switch may be opened during certain shop maintenance procedures and in instances where the engine is shut down and the locomotive taken out of service for an extended layover. This will prevent the battery from being discharged in the event the lights or other low voltage devices are inadvertently left operating during the layover.
AR10 Generator Field 100-ampere Circuit Breaker

The AR10 generator receives its excitation through a pair of slip rings connected to the D14 alternator output through a controlled rectifier. The circuit breaker is provided to protect the controlled rectifier and the generator field windings.

NOTE: When circuit breakers trip, the trigger moves to mid position. To reset move the trigger all the way to OFF then move to ON.

CIRCUIT BREAKER PANEL

This panel is located in the fuse cabinet above the fuse panel.

Lights 30-ampere Circuit Breaker

This circuit breaker must be ON to supply power for the individual switches provided for cab, step, engine room, class and ground and gauge lights.

Headlight 30-ampere Circuit Breaker

This circuit breaker must be ON to supply current to headlights which are further controlled by selector switches on the control stand.

Local Control 30-ampere Circuit Breaker

This circuit breaker must be in the ON position before operation of the locomotive is possible. During operation it establishes "local" power from the auxiliary generator to operate heavy duty switchgear, and various control devices.

Control 40-ampere Circuit Breaker

This circuit breaker must be in the ON position before locomotive operation is possible. It sets up the fuel pump and control circuits for engine starting. Once the engine is running, power is supplied through this breaker from the auxiliary generator to maintain operating control.
Auxiliary Generator Field 30-ampere Circuit Breaker

The field excitation circuit of the auxiliary generator is protected by a 30-ampere circuit breaker. This circuit breaker must be ON at all times during locomotive operation.

In the event that the circuit breaker is tripped it will stop auxiliary generator output to the low voltage system and will also stop fuel pump operation. An alternator failure (no power) alarm would then occur. The engine will return to idle speed and finally stop from lack of fuel.

Fuel Pump 15-ampere Circuit Breaker

The fuel pump circuit breaker must be ON for normal operation.

Miscellaneous Circuit Breakers

A circuit breaker is included for the hot plate and cab heaters (40-amp). The circuit breaker should be placed in the ON position to obtain the desired operation.

Test Jacks

The cabinet mounted test jacks are located in the high voltage system. When telephone plugs or 7/32” metal rods are inserted in the jacks, various relay voltage coils are disconnected from the main generator. This enables calibration of circuits through the use of a fixed voltage from an MG set.

CAUTION: High voltage is present at the test jacks during locomotive operation.

ENGINE CONTROL PANEL

The engine control panel is located at the upper right hand corner of the electrical cabinet that forms the rear wall of the cab. This panel contains the isolation switch, traction motor cutout switch and engine stop button. A brief description of their individual functions is provided.
ENGINE CONTROL PANEL

TRACTION MOTOR
CUT OUT
NORMAL
F: 124
F: 265
F: 326

RUN
START
ISOLATION SWITCH

STOP
Traction Motor Cutout Switch
In the event of a defective traction motor, the traction motor cutout switch can be operated to cut out the defective motor. This permits operation with four motors. Isolation switch must be placed in "start" position prior to "cutting out" traction motors. The power control system automatically limits power to prevent overloading the operative motors. Dynamic brakes become inoperative when any pair of motors cut out.

Engine Stop Pushbutton
The diesel engine will stop whenever the engine stop pushbutton is pressed. The action of the pushbutton is immediate therefore it need not be held in until the engine stops.

Isolation Switch
The isolation switch has two positions, one labeled START, the other labeled RUN. The functions of these two positions are as follows:

1. START Position
   The isolation switch is placed in this position whenever the diesel engine is to be started. The start switch is effective only when the isolation switch is in this position. The START position is also used to isolate the unit, and when isolated the unit will not develop power to respond to the controls. In this event the engine will run at idle speed regardless of throttle position. This position will also silence the alarm bell in the event of ground relay and alternator failure. It will not however, stop the alarm in the event of engine protector operation, low oil pressure or hot engine.

2. RUN Position
   After the engine has been started, the unit can be placed "on the line" by moving the isolation switch to the RUN position. The unit will then respond to control and will develop power in normal operation.

Locomotive Control Stand and Instrument Panel
The locomotive control stand and instrument panel contains the switches, gauges and operating levers used by the operator during operation of the locomotive. The individual components of the controller are described, together with their functions, in the following paragraphs.

Air Gauges
Air gauges indicating main reservoir, equalising reservoir, brake pipe, and brake cylinder pressures and a brake pipe flowmeter are prominently located in front of the driver.
Load Current Indicating Meter

The locomotive pulling force is indicated by the load current indicating meter. This meter is graduated to read amperes of electrical current, with 1500 being the maximum reading on the power scale, and 800 on the dynamic brake scale.

The meter is connected so as to indicate the current flowing through the No. 2 traction motor. Since the amperage is the same in all motors, each motor will carry the amount shown on the meter. Since the traction motors receive the power from the main generator, the meter readings may be multiplied to determine the approximate generator current output. The multiplying factor is 3 since the traction motor power circuit consists of three parallel paths.

Thus a meter reading of 200 amperes would indicate a generator output of 600 amperes.

On locomotives equipped with dynamic brakes, the brake current indicating meter indicates braking effort during operation of dynamic brakes. Since the dynamic brake regulator controls maximum braking current, the meter should seldom if ever indicate more than 600 amperes. This is the rating of the dynamic braking resistor grids.

Indicating Lights

Indicating lights are installed to provide a visual warning of operating difficulties. The functions of these lights are as follows:

1. Excitation Limit (Amber)

This light will shine if main generator field current becomes excessive. After a 60 second delay engine speed will return to idle and GF contactor will drop out so as to protect the field circuit from damage.
2. Alternator Failure Light (Blue)

The alternator failure light will come on, and the alarm bell will ring any time the no AC voltage relay (NVR) opens with the isolation switch in RUN position and the ER switch in ON position. This will occur if the engine stops for any reason or if D 14 alternator failure occurs during operation.

3. Hot Engine Light (Red)

When engine water temperature reaches 208°F, the alarm will ring and the light will shine.
Isolate engine and investigate cause.
Check water level.

All radiator shutters should be open and two radiator cooling fans running.

Light goes out and bell stops ringing when engine water temperature drops to 198°F.

CAUTION: Should it be necessary to remove the pressure cap from the header tank extreme care should be taken to turn the cap slowly. The cap should NOT be removed while the hot engine alarm is ringing.

4. Ground Relay Light (Red)

This light indicates that a high voltage ground fault or a phase unbalance to the A.C. Windings in the A.R.10 alternator has occurred.

The Ground Relay (GR) is energised and held in by a mechanical latch.

Generator field excitation is lost, engine speed is reduced to idle and the alarm bell sounds in all units in a multiple consist. The GR light will be on only in the defective unit.

To Reset

Return throttle to idle and reset by pressing the GROUND RESET button adjacent to the light.
Proceed with normal operation.
Should the alarm bell ring for the third time after using the GROUND RESET button twice the affected unit should be isolated (isolation switch in START). Failure to observe this procedure could result in severe damage to the A.R.10 alternator. The routine procedure established by the railroad should be used to report the light indication and alarm but no action should be taken to cancel a small enunciator light on the Ground Relay. This light should be reset by maintenance personnel only.

NOTE: The Ground Relay does not indicate ground faults in the low voltage circuits.

5. Wheel Slip Light (Red)

Intermittent flashing of the wheel slip light indicates that the wheel slip control system is doing its job and is correcting the slips. The throttle and locomotive power need not be reduced unless severe lurching threatens to break the train.

*When wheel slip occurs*

Power to the traction motors is automatically reduced.
Wheel slip light shines.
Sand is applied automatically.

After 5 to 8 seconds sanding stops.
Full power is re-applied when wheel slip stops.

*If wheel slip light flashes repeatedly*—
and train surging occurs reduce power by operating the manual power control or by reducing throttle.

*If the light persists.* This may indicate a pair of sliding wheels or a circuitry fault. Check by stopping the train then start slowly with an observer on the ground to check that all wheels are rotating. If wheels are locked notify the locomotive depot and do not attempt to move the locomotive.

*Wheel Creep*

The early stages of Wheel slip.
Power to traction motors is slightly reduced. Indicator light will not shine. Sand will be supplied automatically.

After 5-8 seconds sanding stops.
Sand Button

A foot-operated sanding switch is located on the floor adjacent to the driver’s control stand and is provided to operate the sanding magnet valves manually.

To test operation of sanders.

With—
Main air reservoir charged.
Battery knife switch CLOSED.
Control circuit breaker ON.
Control and fuel pump switch ON.
Place reverser in FORWARD or REVERSE
Press foot sanding button.
Observe the discharge of sand.

6. Brake Warning Light (Red)

A brake warning light is installed on units equipped with dynamic brakes and functions in conjunction with a brake warning relay. The purpose of the relay and light is to indicate excessive braking current when operating in dynamic braking.

Due to the use of an automatic brake limiting regulator, the warning light should seldom if ever come on and then only momentarily. Correction for excessive current generally occurs automatically and quite rapidly.

In the event that the brake warning light comes on and does not go out quickly, the braking current should be immediately reduced to prevent possible equipment damage.


The manual power control light will shine when the manual power control switch is placed ON and the throttle is opened.

A manual power control rheostat on the instrument panel may then be used to make fine adjustments in power below that normally provided in the throttle notch being used in conjunction with the manual power control feature at the time.
8. Engine Protector (Amber)

A mechanism to detect low engine lubricating oil pressure is built into the engine governor.

This mechanism is actuated by true oil pressure failure or by dumping oil from the engine oil line leading to the governor. In either event a small button will pop out of the governor body, indicating that the mechanism has tripped the low oil alarm switch. The red light on the engine control panel will come on to indicate that the low oil mechanism has tripped. When a Crankcase (Oil Pan) Pressure/Low Water/Low Oil alarm occurs it is necessary to determine whether the crankcase pressure—low water detector has tripped to dump engine oil from the line leading to the governor or whether a true oil failure has occurred. This can be determined by checking the crankcase pressure—low water detecting device, at the governor end of the engine for protruding reset buttons. A protruding upper button indicates excessive oil pan pressure; a protruding lower button indicates low water.

NOTE: The reset buttons on some detectors will not latch in while the engine is shut down, and on some detectors the button will trip at engine start. Always check and press the reset button immediately after starting the engine.

In a multiple consist the alarm sounds in all units. The light shines only in the defective unit.

Operating Switches

A group of switches is located on the control stand each identified by a name plate indicating switch function. The switches are in the ON position when moved upward.

Before the engine is to be started, the control and fuel pump switch must be placed ON. To obtain power from the locomotive, the generator field switch must be ON. These switches are located on the instrument panel.
TROUBLE SHOOTING

INTRODUCTION

This section is devoted to operational problems that may be encountered on the road and the steps that can be taken to determine their cause and to make necessary corrections. No attempt is made to provide detailed explanations of the equipment functions concerned.

Troubles occurring on the road and the resulting delays can be minimized through proper locomotive inspection, maintenance and operation. When operating problems do occur, however, it is important that they be quickly eliminated. Towards that end, a good, thorough understanding of locomotive equipment function is helpful. This basic knowledge, together with the suggestions given in this section should provide the necessary means for achieving the “on time” performance desired.

GENERAL PROCEDURE

Safety devices automatically protect the equipment in case of faulty operation of almost any component. In general this protection is obtained by unloading or preventing the loading of the diesel engine, with a resulting loss of locomotive pulling power. In most instances, the diesel engine speed will be reduced to idle. Operating difficulties are usually indicated by the ringing of an alarm bell and the lighting of one or more signal lights. The alarm circuit is arranged so that the bells will ring in all units of a multiple unit consist, but the signal light will be on only in the unit experiencing the trouble. With this arrangement the unit in trouble can be quickly detected.

ALARM BELL RINGS — NO SIGNAL LIGHTS ON IN LEAD UNIT

A multiple unit consist may be operated from an isolated lead unit. (Isolation Switch in START).

Cause — 1. If the bell rings continuously the fault is in a trailing unit and may be one of the following:

(a) Hot engine—Red. Hot Engine light will shine in defective unit. Engine speed and power will remain normal in all units. Refer Alarm Signal Lights in Trouble Shooting Section for correction.
(b) Ground Relay—Red. Ground Relay light will shine, engine speed will reduce to idle, and power is lost in the defective unit only.
Refer “Alarm Signal Lights” in Trouble Shooting Section for correction.

(c) Excitation Limit Relay—Amber. Excitation Limit Light will shine, engine speed will reduce to idle and power is lost after 60 secs. (GF drops out).
Refer “Alarm Signal Lights” in Trouble Shooting Section for correction.

(d) D14 Alternator Failure—Blue Alternator Failure Light will shine (no volt relay NVR dropped out) engine speed may be reduced to idle or engine may be stopped.
Refer “Alarm Signal Lights” in Trouble Shooting Section for correction.

(e) Engine Shuts Down—Blue Alternator Failure light will shine. (No volt relay NVR dropped out). Refer “Alarm Signal Lights” in Trouble Shooting Section for correction.

ALARM SIGNAL LIGHTS

Colored alarm signal lights are located on the engine control stand.

RED — HOT ENGINE

Cause — Excessive engine cooling water temperature.

Effect — Alarm bells ring in all units. Engine speed and power remain normal.

Correction — To silence the alarms and extinguish the light it will be necessary to reduce engine cooling water temperature.

1. Isolate unit and allow engine to run at idle.

2. Check water tank to see if there is sufficient water in system.
3. Check to see if cooling fans are running.

4. Shutters should be open. If closed, check position of shutoff valve in air supply line.

**BLUE - ALTERNATOR FAILURE.**

**Cause** — D14 alternator failure; thus, no AC auxiliary power is being generated, NVR drops out and excitation is removed from the main generator. May be due to loss of D14 alternator excitation or electrical difficulty in the system (true failure). May also be caused by the diesel engine stopping for any reason while on the line (false failure).

**Effect** — Alarm bells ring in all units. If the failure was due to electrical fault, the engine in the unit concerned will go to idle speed.

**Correction** — To silence alarms, isolate unit. Method of correction depends upon whether failure was due to electrical or mechanical fault.

A. Engine Stopped (not true D14 failure)

1. Engine overspeed device tripped. Check lever position, reset if necessary.

2. Low water or crankcases (oil pan) pressure detector tripped. The engine protector light will also be on and governor low oil plunger tripped.

3. Engine starving for fuel. Observe for proper fuel flow through return sight glass by operating fuel pump. If fuel is not evident, check reasons given in this section under "Insufficient Fuel.”

4. Throttle lever in STOP position.

5. Low oil pressure. Engine protector light will be on and governor low oil plunger tripped.

6. Hot Engine Oil Detector — Engine protector light will be on and governor low oil plunger tripped.

7. FPC (fuel pump contactor) de-energised (engine stops immediately).
B. D14 Failure (engine idling).

1. Blown 60-ampere alternator field fuse.
2. Blown 150-ampere auxiliary generator fuse.
3. Tripped 30-ampere auxiliary generator field circuit breaker.

**AMBER-ENGINE PROTECTOR—LOW OIL/LOW WATER/CRANKCASE PRESSURE/HOT OIL DETECTOR.**

**Cause** — Low oil pressure or high oil temperature in the engine or lubricating systems. May be due to insufficient oil, excessively hot oil, diluted oil, or clogged strainers or incorrectly seated oil strainer gasket.

A low oil pressure indication is also given when the crankcase pressure/low water detecting device is tripped, or hot oil detector has operated. This is because these devices dump oil from the low oil pressure detector in the engine governor.

**Effect** — The diesel engine in the unit concerned will be stopped and the amber light on the engine control stand will be on. The pushbutton on the governor will be out, with the red indicating band exposed. The blue ALTERNATOR FAILURE light will also come on as NVR drops out due to no D14 voltage. The alarm bell will ring if the isolation switch is in RUN.

**Correction** — The following steps should be taken to correct or determine cause of difficulty.

1. Isolate unit to stop alarm bells.
2. Reset governor trip button. Amber engine protector light will go out.
3. Check engine lubricating oil level using dipstick. Oil should be approximately six inches above the FULL mark when engine is stopped.
4. Observe for external oil leakage from broken pipes.
5. Check the low water and crankcase (oil pan) pressure detecting device mounted on the engine. If the lower button protrudes, the failure is due to low water. If the upper button protrudes, the failure is due to excessive oil pan pressure.
NOTE: If governor low oil plunger trips to shut the engine down, but the crankcase and low water detector buttons remain set, check oil and water levels. If oil level is satisfactory and water level is marginal, the hot oil detector may have tripped. There is no indicator for such a trip except a very hot engine condition. Do not attempt to restart engine. Report engine shutdown circumstances to authorized maintenance personnel.

**Upper Button Protrudes**

Cause — Oil pan pressure exceeds a predetermined positive pressure setting. May be the result of gases entering the oil pan through cracked pistons, badly worn rings, broken rings, or due to a dirty oil separator.

Effect — Engine shut down.

Correction — Reset governor low oil trip plunger. Manually reset the device by holding the button in for 5 seconds. Proceed with the checks shown for low oil shutdown. It is not recommended that the upper button (crankcase pressure) be reset more than once unless it is apparent that the latching mechanism is defective.

**Lower Button Protrudes**

Cause — Low water level, sudden loss of engine water, or low water pressure at engine start.

Effect — Engine shuts down. If water level is only slightly low, the engine may shut down only at high throttle positions.

Correction — Check for water leaks. Add water. Reset governor low oil trip plunger. Press detector reset button and hold for 5 seconds immediately after restarting engine.

6. Check that lubricating oil viscosity is not reduced due to dilution with fuel oil.

7. Check that oil viscosity is not reduced due to excessive heat. In such case the hot engine alarm may also be activated.
8. Restart engine after reset buttons have been pressed and corrective action taken. Observe oil pressure on gauge. It should be a minimum of 9 psi with engine at idle.

CAUTION: In the event of continued low oil pressure, or low water, the governor trip button will again move to stop the engine. The engine should not be repeatedly started or forced to run when the governor keeps shutting down the engine. The engine should NEVER be manually operated by using the layshaft lever to take control away from the governor when the governor persists in stopping the engine.

RED — GROUND RELAY

Cause — Insulation failure, presence of water, or an electrical arc in high voltage circuits or phase unbalance to the A.C. Windings in the A.R. 10 Alternator.

Effect — The light comes on when the ground relay trips. Engine speed will be reduced to idle, power is lost, and the alarm bell rings.

Correction — Press the ground reset button on the control stand. The light will go out, the bell will stop, power will be smoothly restored and engine speed will return to that called for by throttle position on the lead unit.

No action should be taken to cancel a small enunciator light on the Ground Detection Light Relay (GDL) in the electrical cabinet. This light should be reset by maintenance personnel only.

WARNING: When the alarm rings for the third time after using the ground reset button twice, the affected unit should be isolated.

AMBER — EXCITATION LIMIT

Cause — Tripped excitation limit delay relay due to excessive generator field current. May be caused by defective excitation circuit or a defective rate control panel.
The overvoltage relay provides protection from excessive voltage from the main generator. If main generator voltage rises above an acceptable level, the OVR relay picks up. Pickup of OVR provides a feed to the ELD relay and also operates to discharge the rate control capacitor. The immediate response contacts of ELD provides a feed to ELR and also operate to discharge the rate control capacitor.

If the overvoltage condition persists for 60 seconds, the time delay contacts of ELD operate to drop out GF and also causes the alarm to sound, excitation limit light to come on, and provides holding circuit for ELD. Power can be restored by returning the throttle to IDLE, to drop out ELR and ELD, then advancing throttle to the desired position. If the alarm and excitation light comes on again after the unit is placed on the line and power is restored, isolate the unit.

Effect — The alarm bell rings, the engine on the unit affected will go to idle speed and the generator field contactor (GF) will drop out after 60 seconds.

Correction — Return throttle to idle position to stop the alarm and drop out the excitation limit relay. After a slight delay, reopen the throttle. If the excitation limit light and alarm occurs again, isolate the unit.
RED — WHEEL SLIP

Cause — Severe wheel slip causes the wheel slip light to come on. Minor and moderate slipping does not cause the light to come on.

Effect — Minor slips are corrected by instantaneous power reduction. Moderate slips bring about a greater reduction of power in addition to a timed application of sand. Severe slipping causes the wheel slip light to come on.

Correction — Corrective action is automatic. Power should be reduced only if severe lurching threatens to break the train.

WARNING: A unit experiencing repeated and persistent wheel slip action should not be isolated and allowed to remain in the locomotive consist unless inspection reveals that all wheels are capable of rotating freely.

RED — BRAKE WARNING

Cause — Excessive dynamic braking current.

Effect — No noticeable effect. Dynamic brake resistor grid damage is possible if corrective action is not taken.

Correction — Excess braking current is usually quickly and automatically corrected by the dynamic brake regulator. In the event the warning light blinks excessively, the throttle should be moved to reduce braking strength. The light should never be allowed to blink on and off more than three seconds.

CORRECTION OF OPERATING DIFFICULTIES

INSUFFICIENT FUEL

Insufficient fuel will cause erratic engine operation. Lack of fuel will cause engine to shut down. It will also prevent an engine from being started.

Condition of the fuel system may be determined by observing the two sight glasses mounted on top of the filter assembly located at the governor end of the engine. The glass closest to
the engine should be full whenever the fuel pump and engine are 
running. The other adjacent glass should always be empty.

FOR FUEL PUMP TO OPERATE
1. Main battery switch must be closed.
2. Control and local control circuit breakers must be ON.
3. Control and fuel pump switch must be ON.
4. Fuel pump 15-ampere circuit breaker must be ON.
5. FPC and FPR coils must be energized.
6. Auxiliary generator must be developing power.

NO FUEL WITH PUMP RUNNING
1. Lack of fuel in tank.
2. Slipping or broken coupling between motor and pump.
4. Clogged suction or discharge filters.

ENGINE CANNOT BE STARTED
Engine starting difficulties fall into two categories; namely, 
engine does not rotate in START position, or engine rotates but 
does not fire. The following items should be checked in either 
event.

Engine Does Not Rotate
1. Main battery switch must be closed.
2. Isolation switch must be in START position.
3. Starting 400-ampere fuse must be good and in place.
4. Control and local control circuit breakers must be closed.
5. Control and fuel pump switch must be in ON position:
6. GS and GSA contactors must pick up.
7. Both cranking motor pinions must mesh.
8. Engine must not contain hydraulically locked cylinder. Always report stalled cranking attempts to proper maintenance personnel.

**Engine Rotates But Does Not Fire**

1. Engine overspeed trip lever must be set.
2. Low oil pressure button in governor must be in.
3. Fuel system must be sufficiently primed, and layshaft lever must be positioned at about 1/3 rack.
4. Local control circuit breaker must be in ON position.
5. Governor shutdown solenoid DV must be de-energized.

**ENGINE STOPS SOON AFTER STARTING**

1. Fuel pump circuit breaker must remain closed.
2. Control and local control circuit breakers must remain closed.
3. Control and fuel pump switch must remain ON.
4. Low water and crankcase (oil pan) pressure detector buttons must be set.
5. If the engine stops when the isolation switch is turned to RUN the throttle may be in STOP position.

**ENGINE DOES NOT RESPOND TO THROTTLE**

In instances where an engine is running normally at idle speed but does not speed up when throttle is advanced, the indication is that the governor speed control solenoids AV, BV and CV are not receiving power. Generally, this condition would be due to the ER relay being de-energized. The following items should be checked:

1. Ground and fault relays must be set.
2. NVR must be energized.
3. Isolation switch must be in RUN.
4. DPC (Dynamic Pneumatic Contactor) and PCR (Pneumatic Control Relay) must be picked up.
5. Engine run switch must be ON.
6. Control circuit breaker and control and fuel pump switch must be in ON position. In addition to lack of throttle response with these devices OFF, the engine will in a few minutes shut down from lack of fuel.

7. Excitation limit and overvoltage relays not functioning properly.

**DYNAMIC PNEUMATIC CONTACTOR (DPC) NOT PICKED UP**

The Dynamic Pneumatic Contactor (DPC) will drop out when brake pipe pressure falls below 45 psi. This may result from—

(a) An emergency brake application by the driver.
(b) A Vigilance Penalty Valve application.
(c) Conductor or Guard's valve application.
(d) Train break in two.

Pneumatic Control Relay (PCR) is de-energized when DPC drops out. The speed and power of ALL engines in a multiple unit consist is reduced to IDLE. No alarm bells will ring. The PCR will reset automatically if the throttle is placed in IDLE and brake pipe pressure is restored to more than 56 psi, the pick up value of DPC.

In the event of a brake application from (a) (b) (c) or (d) above proceed as follows:

For (a) place automatic brake handle in RELEASE. Independent brake handle in FULL APPLICATION. Throttle in IDLE.

For (b) proceed as in (a) above and also lift the pin on the penalty application valve on the side of the control stand.

For (c) and (d) return throttle to IDLE. It is recommended that after the train stops, the automatic brake valve be placed in emergency position and allow to remain there until the cause of the application has been corrected. Then proceed as for (a) above.

**LOCOMOTIVE DOES NOT LOAD UP**

In instances where the diesel engine is running and responds,
properly to throttle but the locomotive does not load up, the following points should be checked:

1. Reverse lever must be in either forward or reverse.
2. Generator field switch must be ON.
3. Generator field circuit breaker must be ON.
4. Power contactors must pick up.
5. Generator field, contactor must pick up and overriding solenoid must remain de-energized.

**ENGINE GOES TO IDLE DURING OPERATION**
See possible causes in preceding article entitled “Engine Does Not Respond To Throttle.”

NOTE: Control circuit breaker may be tripped. The trigger will be in mid position. To reset, move the trigger all the way to OFF then move to ON.

**ENGINE STOPS DURING OPERATION**

In instances where a diesel engine stops during normal operation, the following items may be responsible.

1. Throttle may be in STOP position.
2. Engine overspeed trip may have occurred.
3. Low oil button on governor may be out.
4. Crankcase (oil pan) pressure / low water detector tripped.
5. Hot Engine Oil Detector causing governor low oil button to trip.
6. Insufficient or lack of fuel. See preceding fuel system difficulties.
7. Auxiliary generator fuse or circuit breaker may have opened.
8. FPC de-energized. Local control circuit breaker tripped.
9. Control circuit breaker may be tripped.
BATTERY CHARGING METER SHOWS DISCHARGE

With the diesel engine running, the auxiliary generator should provide all low voltage current needs. The battery charging ammeter should read either zero or charge. If it continually reads discharge, the following should be checked.

1. Auxiliary generator fuse must be good and in place.

NOTE: A strong discharge reading at engine stop, followed by a burned out auxiliary generator fuse, indicates a shorted battery charging rectifier.

2. Auxiliary generator field circuit breaker (30-ampere) must be ON.

3. Voltage regulator must be operative and properly adjusted.

UNUSUAL OPERATING PROBLEMS

In the majority of instances, the various safety devices will function in the event of trouble to safeguard the equipment by unloading the engine, or causing it to go to idle or stop. There are instances however, when such action is not automatically taken and it may be advisable to take manual action. Since these occasions are unusual, each should be handled individually, using good judgment. The following suggestions may be helpful.

Mechanical Problems

1. Smoke Coming Out of Exhaust — Operation may continue.

2. Oil or Fire Coming Out of Exhaust — Stop engine.

3. Smoke in Engine Room Coming from Engine — Stop engine, DO NOT REMOVE ANY INSPECTION COVERS.

4. Governor Low Oil Button Trips Repeatedly — This may be due to low oil, positive crankcase pressure, hot oil or low water pressure. If the shutdown is due to low or hot oil or positive crankcase pressure refer to “Alarm Signal Lights” (Engine Protector) in Trouble Shooting section. If shutdown is due to low water, it may be possible to operate the engine at reduced throttle if the low water reset button on the crankcase pressure/low water detector stays in when pressed after engine is restarted.

5. Unusual Noises — Investigate source. Stop engine or discontinue operation to prevent damage if noise is pronounced.
6. Engine Cylinder Test Valve Leaking — Do not allow engine to operate with leaking or blowing test valves.

7. Safety Valves Popping On Air Compressor Intercooler or Main Reservoir—Continue operation.

8. Engine Overspeed Trip Stops Engine Repeatedly—Operate in reduced throttle notches where possible.

**Electrical Problems**

1. Ground Relay Tripped Light Comes on Repeatedly—Isolate unit after three indication. Stop locomotive and check to see that all wheels can rotate freely.

2. Continued Wheel Slip Indication—Isolate unit; Stop locomotive and check to see that all wheels can rotate freely.

3. Loss of power is evident, but no alarm indication is given and the reason for the difficulty can not be determined. Operation may continue, but the condition should be reported to proper maintenance authority.

**CAUTION:** Excitation of the main generator for test purposes without load or lightly loaded should be restricted to an absolute minimum.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>W.S.C.</td>
<td>Wheel Slip Control Panel (IDAC)</td>
</tr>
<tr>
<td>D.B.R.</td>
<td>Dynamic Brake Regulator</td>
</tr>
<tr>
<td>B.W.R.</td>
<td>Brake Warning Relay</td>
</tr>
<tr>
<td>B.W.A.</td>
<td>Brake Warning Auxiliary Relay</td>
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<tr>
<td>W.S.14</td>
<td>Wheel Slip Relays</td>
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<td>W.S.25</td>
<td>Wheel Slip Relays</td>
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<tr>
<td>W.S.36</td>
<td>Wheel Slip Relays</td>
</tr>
<tr>
<td>C.R.</td>
<td>Rectifier</td>
</tr>
<tr>
<td>B.R.</td>
<td>Brake Relay</td>
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<tr>
<td>T.D.S.</td>
<td>Time Delay Sanding Relay</td>
</tr>
<tr>
<td>E.R.</td>
<td>Engine Relay</td>
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<tr>
<td>F.P.C.</td>
<td>Fuel Pump Relay</td>
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<tr>
<td>G.F.R.</td>
<td>Generator Field Relay</td>
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<tr>
<td>N.V.R.</td>
<td>No Volt Relay (A.C.)</td>
</tr>
<tr>
<td>I.S.A.</td>
<td>Isolation Switch Auxiliary Relay</td>
</tr>
<tr>
<td>W.L.</td>
<td>Wheel Slip Light Relay</td>
</tr>
<tr>
<td>R.A.</td>
<td>Reversing Auxiliary Relay</td>
</tr>
<tr>
<td>P.R.R.</td>
<td>Power Control Relay</td>
</tr>
<tr>
<td>F.S.R.A.</td>
<td>Field Shunt Auxiliary Relay</td>
</tr>
<tr>
<td>P.C.R.</td>
<td>Pneumatic Control Relay</td>
</tr>
<tr>
<td>F.P.R.</td>
<td>Fuel Pump Relay</td>
</tr>
<tr>
<td>F.O.R.</td>
<td>Forward Relay</td>
</tr>
<tr>
<td>R.E.R.</td>
<td>Reverse Relay</td>
</tr>
<tr>
<td>G.D.L.</td>
<td>Ground Detection Light Relay</td>
</tr>
<tr>
<td>V.R.</td>
<td>Voltage Regulator (Aux. Gen.)</td>
</tr>
</tbody>
</table>
G.R.  Ground Relay
P.B.D.  Power Brake Delay
E.L.D.  Excitation Limit Delay Relay
O.V.R.  Overload Relay (Main Gen.)

T.R.P.  Throttle Response Panel
C.O.R.  Cut Out Relay (Motors)
R.C.P.  Rate Control Panel
R.V.R.A.  Reversing Auxiliary Relay
F.C.T.  Field Current Transducer
E.L.R.  Excitation Limit Relay
M.F.P.  Motor Field Protection Relay
ER LIGHT

RESISTOR MOTOR FIELD SHUNT A
RESISTOR MOTOR FIELD SHUNT B
RESISTOR MOTOR FIELD SHUNT C
SCR

RESISTOR

BATTERY CHARGING

RECTIFIER

R4 R5 R8 R1 R6 R7 R16 R21 R19 R18

R10

R71 R72

R3 R4 R5 R6 R7 R8

RESISTOR PANEL

RESISTOR PANEL

GPA GF GFD FS GS B BJ SP36

GSA RVF25 B6.2 M12 RVF36 RVF14

MCO25 MCO36 MCO14

ELECTRICAL CABINET - ENGINE ROOM SIDE
ELECTRIC CABINET – ENGINE ROOM SIDE

Top of Cabinet
S.C.R.  Silicon Controlled Rectifier
C.R.–B.C.  Battery Charging Rectifier

Bottom of Cabinet
G.F.A.  Generator Field Auxiliary
G.F.  Generator Field Contactor
G.F.D.  Generator Field Decar Contactor
F.S.  Field Shunting Contactor (Motors)
G.S.  Starting Contactor (Engine)
G.S.A.  Starting Auxiliary Contactor (Engine)
R.V.F.14  Forward and Reverser Switches
R.V.F.25  Forward and Reverser Switches
R.V.R.36
B.  Brake Power Control
B.3
B.54  Brake Transfer Switches
B.62
M.12  Motor Power Switch
L CLASS
MAIN LINE ELECTRIC
LOCOMOTIVES
ELECTRIC SHOCK.

Precautions.

Enginemen must exercise due care in the performance of their duties to avoid risks of electric shock. Before handling or operating any portion of the electrical equipment, employees must make sure that proper precautions for the safety of himself or others have been adopted.

To Release an Electric Shock Victim.

1. Insulate yourself from earth by standing on some DRY non-conducting material such as folded newspaper, rubber, linoleum, wood, cloth, etc.

2. Avoid personal contact with live conductors, or with victim or his clothing or any article he may be holding. Particular care should be taken to avoid patient's arm pits.

3. Protect your hands from contact with victim or live conductors by using dry non-conducting material such as rubber pouch, cap or hat, folded newspaper.

4. Release the victim.

5. If no means of insulating the hands is readily available pull the victim away with a loop of dry rope or a crooked stick. Do not use an umbrella.

6. Make every effort to summon a doctor and if required, have power switched off.

Treatment of Electric Shock.

Alternative methods of treatment of electric shock are fully explained in the General Appendix.
TRACTION MOTOR ELECTRICAL CONNECTIONS.

To obtain efficient operation at different speeds, three types of traction motor electrical connection are used:

1. SERIES—for starting and heavy pulling.

![Series Diagram]

2. SERIES—PARALLEL—for intermediate speeds.

![Series-Parallel Diagram]

3. PARALLEL—for high speeds.

![Parallel Diagram]

Transition from one type of connection to another is effected by movement between certain notches of the controller handwheel.
NO. 1 ELECTRICAL CABINET.

1. NO. 2 PANTOGRAPH ISOLATING SWITCH—

2. NO. 1 PANTOGRAPH ISOLATING SWITCH—
   Allow the pantographs to be isolated from the power circuits.

3. MAIN ISOLATING SWITCH—Permits the traction motor power circuits to be isolated from the pantograph.

4. AUXILIARY ISOLATING SWITCH—Permits the auxiliary high tension circuits to be isolated from the pantographs and earthed.

5. MAIN OVERLOAD RELAY—Opens the line breakers if an overload fault should occur on a power circuit.

6. MOTOR OVERLOAD RELAYS—Open the line breakers if an overload fault should occur on a traction motor circuit.

7. MOTOR OVERLOAD AND EARTH FAULT RELAY—Opens the line breakers if an overload fault should occur on a traction motor circuit, and cuts off electric braking if an earth fault occurs on a traction motor circuit.

8. INTERLOCK RELAY—Energised and closed in Notch I only to permit the line breakers to close and the traction motors to take power.

9. NO-CURRENT RELAYS—Open the line breaker contactors and protect the equipment from sudden restoration of power after a power supply failure on the overhead.

10. LINEBREAKER CONTACTORS—Connect the traction motor circuits to the main high tension supply.

11. MOTOR CONTACTORS—Arrange the traction motor groupings.

12. RESISTANCE CONTACTORS—Cut the accelerating resistances out of circuit during notching up.

13. MOTOR CUT-OUT CAM SWITCH—Has four positions which permit traction motor pairs to be cut out of circuit in case of need.

14. MOTOR CUT-OUT TRANSITION SWITCH—Changes over the motor connections during transition to or from series-parallel, when a pair of motors is cut out of circuit.

15. CROOK STICK—For operating isolating switches.
No. 2 ELECTRICAL CABINET.

1. MOTOR CONTACTORS—Arrange the traction motor groupings.

2. BRAKE EXCITER CONTACTOR—Connects the exciter to the traction motor field circuit when the electric brake is to be used.

3. REVERSER CAM SWITCH K—and

4. REVERSER CAM SWITCH L—Change the traction motor connections to reverse the direction of locomotive movement.

5. FIRST TRANSITION CAM SWITCH—Changes the motor connections from series to series-parallel.

6. SECOND TRANSITION CAM SWITCH—Changes the motor connections from series-parallel to parallel.

7. FIRST FIELD TAP CAM SWITCH—and

8. SECOND FIELD TAP CAM SWITCH—Change the connections to the traction motor fields for weak field operation.

9. POWER-BRAKE CAM SWITCH—Changes the motor connections to separately excite the traction motors when electric braking is used.

10. RESISTANCE BLOWER RELAYS—Light the resistance blower indicator light if any blower stops running.

11. RESISTANCE BLOWER OVERLOAD RELAYS—Open the linebreakers if an overload fault should occur on a resistance blower motor.

12. RESISTANCE BLOWER ISOLATING SWITCH—Permits the resistance blower motors to be isolated from the accelerating resistance.

13. BRAKE RELAYS—Render the locomotive air brake inoperative when electric braking is in use.
NO 3 ELECTRICAL CABINET

1. MOTOR-GENERATOR CIRCUIT BREAKER—Connects the motor-generator motor to the high tension supply, and opens and isolates the motor if an overload or fault should occur on the motor circuit.

2. COMPRESSOR MOTOR CIRCUIT BREAKER—Connects the compressor motors to the high tension supply, and opens and isolates the machines if an overload or fault should occur on a compressor circuit.

3. BLOWER MOTOR CIRCUIT BREAKER—Connects the traction motor blower motors to the high tension supply and opens and isolates the machines if an overload or fault should occur on a blower motor circuit.
4. MOTOR GENERATOR OVERLOAD TRIP CIRCUIT BREAKER—Opens the motor-generator circuit breaker if an overload or fault occurs on its motor circuit.

5. COMPRESSOR MOTOR OVERLOAD TRIP CIRCUIT BREAKER—Opens the compressor motor circuit breaker if an overload or fault occurs on a compressor motor circuit.

6. BLOWER MOTOR OVERLOAD TRIP CIRCUIT BREAKER—Opens the traction motor blower motor circuit breaker if an overload or fault occurs on a traction motor blower motor circuit.

7. No. 1 BLOWER MOTOR RELAY—and

8. No. 2 BLOWER MOTOR RELAY—Light the traction motor blower indicator light if a fault occurs on a blower motor circuit.

9. COMPRESSOR MOTOR CONTACTORS—Operate under control of the compressor governor to start and stop the compressors to maintain the required air pressure in the main reservoirs.

10. MOTOR GENERATOR STARTING CONTACTOR—Closes and short circuits the motor-generator starting resistance when the generator voltage has risen to a satisfactory value.

11. MOTOR GENERATOR STARTING RESISTANCE—Limits the current to the motor-generator during starting.

12. COMPRESSOR MOTOR PERMANENT RESISTANCE—Limits the current to the compressor motors.

13. LIMITING RESISTANCE FOR AUXILIARY MACHINES—Connected in the high tension supply to protect the machines in the event of an earth fault.

14. TRACTION MOTOR FIELD DIVERT RESISTANCES—Are connected across portions of the traction motor fields during weak field operation.
No 4 Electrical Cabinet
No. 4 ELECTRICAL CABINET.

1. VOLTAGE REGULATOR—Maintains constant voltage output from generator.

2. EXCITER FIELD CONTACTORS—Control the exciter field during dynamic braking.

3. No. 1 COMPRESSOR ISOLATING SWITCH—

4. No. 2 COMPRESSOR ISOLATING SWITCH—Permit either compressor motor to be isolated.

5. COMPRESSOR GOVERNOR ISOLATING SWITCH—Permits the compressor governor to be isolated from the compressor control circuit.

6. COMPRESSOR CONTROL CIRCUIT BREAKER—Opens the compressor control circuit if an overload or fault should occur on that circuit.

7. GENERATOR CIRCUIT BREAKER—Opens to protect the generator if an overload or fault occurs on a low tension circuit.

8. LIGHTING ISOLATING SWITCH—Permits the locomotive lighting circuits to be isolated from the low tension supply.

9. CONTROL SUPPLY SWITCH—Permits low tension supply from another coupled locomotive if required.

10. VENTILATION MOTOR CIRCUIT BREAKER—Opens if an overload or fault should occur on the ventilation motor circuit.

11. TRAIN LINE CONTACTORS—Connect control circuits to low tension supply.
DRIVING COMPARTMENT.

1. CONTROLLER HANDWHEEL—Controls traction motor connections and power application during starting and accelerating.

2. REVERSE LEVER—Controls motor connections for required direction of movement.

3. DYNAMIC BRAKE LEVER—Controls motor connections and motor field excitation during dynamic braking.

4. AUTOMATIC BRAKE VALVE—For controlling operation of the automatic air brake on the locomotive and train.

5. INDEPENDANT BRAKE VALVE—To control the straight air brake on the locomotive.

6. BRAKE VALVE ISOLATING COCK—For isolating the brake valves from the brake pipe when the locomotive is being driven from the opposite cab.

7. TRAIN EXAMINER'S BOX—For locking reverse lever during train examination.

8. BRAKE PIPE AND BRAKE CYLINDER PRESSURE GAUGE—and

9. MAIN RESERVOIR AND EQUALISING RESERVOIR GAUGE—For indicating air pressures.

10. SPEED INDICATOR—Indicates running speed.

11. AMMETER, MOTORS 1 AND 3—AND

12. AMMETER, MOTORS 4 AND 6—AND

13. AMMETER, MOTORS 2 AND 5—Show current flowing in traction motor armatures.

14. BRAKE EXCITER AMMETER—Shows traction motor field excitation during dynamic braking.

15. CONTROL SWITCH—Controls and protects the operating control circuits.
16. **FAULT INDICATOR LIGHT**—Lights when a fault or overload occurs in a power circuit.

17. **RESISTANCE BLOWER INDICATOR LIGHT**—Lights when a resistance blower is not operating.

18. **MOTOR BLOWER INDICATOR LIGHT**—Lights when a traction motor blower is not operating.

19. **L.T. LOCO. No. 1 INDICATOR LIGHT**—Lights when the low tension supply is available.

20. **L. T. LOCO. NO. 2 INDICATOR LIGHT**—Lights when low tension supply is available on the other unit when two locomotives are coupled in multiple-unit.

21. **PANTOGRAPH RAISE PUSH BUTTON**—and

22. **PANTOGRAPH DOWN PUSH BUTTON**—For remote control of pantograph E.P. magnet valves.

23. **OVERLOAD RESET PUSH BUTTON**—For remote resetting of tripped relays.

24. **HEADLIGHT SWITCH**—For control of headlight.

25. **LIGHTING SWITCH**—For control of cab, nose compartment and instrument lighting.

26. **SANDING LEVER**—Controls the air operated sanders.

27. **WINDSCREEN WIPER**—For wiping rain water from cab front windshield.

28. **LOW PRESSURE INDICATOR**—Operates and displays an arm marked STOP if the main reservoir air pressure falls below a satisfactory pressure.

29. **BRAKE PIPE FLOW INDICATOR**—Indicates abnormal brake pipe flow.
1. Main lighting.
2. Central equipment compartment lighting.
3. Headlight.
4. Marker lights.
5. Cab lights.
6. Inspection sockets supply.
8. Hotplate.

1. Headlight.
2. Marker lights.
3. Cab lights.
5. Hotplate.
6. Inspection socket.
LOCOMOTIVE OPERATION.

PANTOGRAPH.

At the top of each pantograph frame are two collector pans which make contact with the overhead contact wire and are fitted with renewable copper contact strips, and curved horns at each end.

The pantograph is held down by a retaining spring, and is raised by admitting compressed air to the pantograph cylinder. The motion of the pantograph cylinder piston overcomes the return spring and allows two extension springs to raise the pantograph and keep it extended against the overhead contact wire at a constant pressure.

An air choke valve situated on the pantograph limits the rising speed to minimise the impact on the overhead contact wire, and permits rapid exhausting of the air in the cylinder on lowering for quick dropping of the pantograph.

NOTE:—DRIVERS ARE NOT ALLOWED ON THE ROOF OF L CLASS LOCOMOTIVES.
TO RAISE THE PANTOGRAPH.

Air Operation.

1. Check pantograph reservoir air pressure. Should be more than 55 lbs—if less than 55 lbs the pantograph must be raised by using the pole provided.

2. Set the pantograph selector valve for the pantograph to be raised.

3. Open the pantograph reservoir wheel stop valve.

4. Press the button on top of the pantograph "raise" magnet valve.

5. See that the pantograph is at rest at the overhead contact wire.

6. Check operation of:
   — motor-generator.
   — traction motor blowers.
   — air compressors.
Hand Operation.

1. Place the reverse lever in the glove box.
2. Open auxiliary high tension circuit breakers.
3. Set the pantograph selector valve to No. 2 pantograph position.
4. Using the wooden pole, raise the pantograph until it is forced hard against the overhead wire, and place bottom end of pole in rack notch to hold pantograph against the overhead.
5. Close auxiliary high tension circuit breakers and check operation of:
   - motor-generator.
   - traction motor blowers.
   - air compressors.
6. When the pantograph reservoir pressure exceeds 70 lbs, press the button on the pantograph “raise” E.P. magnet valve.
7. Remove the wooden pole and replace it in its housing.

CAUTION:—WHILE THE PANTOGRAPH IS RAISED ON THE POLE, NO ATTEMPT MUST BE MADE TO ENTER THE HIGH TENSION CABINETS OR MOVE THE LOCOMOTIVE.

Pantograph Interlock Air Valves.

To ensure that the pantographs are down before any of the high tension electrical cabinet doors can be opened, the air supply to the pantograph cylinder passes through interlocking air valves on the high tension electrical cabinet doors. These doors must be closed and locked by setting the interlocking valves with the reverse lever to complete the pantograph air supply.

![Diagram of pantograph interlock air valves](image-url)
COMPRESSOR MOTOR CIRCUIT.

FROM PANTOGRAPH ISOLATING SWITCH

AUXILIARY ISOLATING SWITCH

LIMITING RESISTANCE

COMPRESSOR OVERLOAD CIRCUIT BREAKER

COMPRESSOR MOTOR CONTACTORS

COMPRESSOR MOTORS

MOTOR PERMANENT RESISTANCE

1500 Volts

CIRCUIT BREAKER

CIRCUIT BREAKER TRIP
CONTROL SUPPLY AND COMPRESSOR GOVERNOR CIRCUITS.

115 Volts

No 2 LOCO
GENERATOR TRAIN LINE

CONTROL SUPPLY SWITCH

LOW TENSION
POSITIVE

COMPRESSOR CONTROL CIRCUIT BREAKER

No 1 END
CONTROL CIRCUIT BREAKER

COMPRESSOR CIRCUIT BREAKER

COMPRESSOR CONTACTOR COILS

COMPRESSOR GOVERNOR CUT-OUT SWITCH

COMPRESSOR GOVERNOR

NEGATIVE TRAIN LINE

No 2 END
CONTROL CIRCUIT BREAKER

No 1 END DRIVING CONTROLS

No 2 END DRIVING CONTROLS

COMPRESSOR GOVERNOR TRAIN LINE

322
OVERHEAD EQUIPMENT.

General Description.

A general description and instructions relating to electrical overhead equipment are contained in the General Appendix.

Faults and irregularities must be reported promptly.

The following are specified as some of the faults or irregularities likely to occur in the overhead equipment:

1. Wires hanging loose; that is, wires which are broken or appear to be out of position.
2. Any article hanging on the overhead conductors.
3. Steady arm attachments disconnected from the wire or disconnected from the structure and hanging on the wire.
4. Excessive flashing or sparking at any particular point.
5. Bridge fittings or guards displaced.
6. Water flowing onto the overhead conductors from verandahs, bridges, etc.
7. Broken insulators or brackets carrying them.
8. Loose parts in section insulators.
9. Displaced or broken structures.

CAUTION: ONLY AN AUTHORISED EMPLOYEE OF THE OVERHEAD STAFF SHALL REMOVE ANY OBSTRUCTION ON THE OVERHEAD WHICH CONTAINS METAL, OR IS SUSPECTED OF CONTAINING METAL.
Terminal Stop Marks.

Where the Overhead Equipment terminates at locations other than those at which buffer stops are provided, Stop Boards are provided 50 feet inside the Terminal clamp or other point where the pantograph would leave the contact wire.

Except where instructions are issued to the contrary the driver must drive from the front cab during shunting or other operations and have such control of the train as to bring it to a stop at least 10 feet from the Stop Board.
Special Overhead Signals.

If repairs to any section of the overhead equipment renders it necessary for the pantographs of electric trains to be lowered when passing the portion undergoing repair the instructions for Special Overhead Repair Signals as contained in the General Appendix must be observed.

1. Stop the train and obtain verbal information from hand-signalman of the place at which repairs are being carried out, and of the structures between which it will be necessary to have the pantograph down.

2. Test pantograph operation in lowering and raising.

3. Start train and obtain as much-momentum as possible prior to lowering the pantograph.

4. At special lower pantograph signal, which will be displayed on a left hand structure, lower the pantograph.

5. When the whole train has passed the special Raise Pantograph Signal, stop the train and raise the pantograph.

IF TRAIN STOPS SHORT OF "R" BOARD, DO NOT RAISE PANTOGRAPH UNTIL ADVISED BY OFFICER-IN-CHARGE OF OVER-HEAD REPAIRS.
DEFECTS AND REMEDIES

General Instructions

See Panto is down before entering H.T. cabinets. Note condition of failure and conduct correct test laid down.

Always reverse starting handle to off then reset after M/C.B’s No.3 cabinet have been reset.

DO NOT attempt to enter H.T. cabinet when Panto is raised on pole and when air is obtained press E.P. raise button before removing pole.

Compressors

High Tension failure will cause M/C.B No.3 cabinet to trip.

Isolate defective comp. by knife switch No.4 cabinet, reset M/C.B and starting handle No.3 cabinet.

Low Tension failure will cause M/C.B No.4 to trip isolate comps. or Governor to clear fault.

If both compressors fail and all M/C.B’s in 3 and 4 cabinets are set OK isolate both compressors and Governor No.4 cabinet — could be an open circuit.

Traction Motor Blowers

Failure to T.M. Blowers indicated by light on panel.

Reset M/C.B No.3 cabinet if it continues to trip no Dynamic Braking.

Starting Handles to all machines must be reset each time M/C.B trips.

Locomotive Fails

Check that Aux. machines are running
Check that Control panel lights are on
Check that Control M/C.B in cab is set
Try to move in both directions
Note whether Fault Light appears Notch 1.
Note whether Fault Light appears Notch 2.
PART 1
When Auxiliary Machines Have All Failed

Check pantograph is making good contact
Check M/C B No.3 cabinet to — Motor Generator Compressors, T.M. Blowers.
If OK try starting handles.
Examine Isolators No.1 cabinet
If all are in order raise other Panto
Still no result power is off
Make enquiries.

PART 2
Motor Generator Only Has Failed

Check Motor Generator M/C.B. No.3 Cabinet
If tripped reset
M/C.B. trips three times get assistance

Multiple Unit

Reverse Control supply switch No.4 cabinet from normal to emergency on defective loco.

PART 3
Control Panel Lights Are Not On

Check Generator M/C.B. No.4 cabinet if tripped reset.
If M/C.B. trips again switch off lights, hot plates heaters etc. not required and reset.
If M/C.B. trips again get assistance.

Multiple Unit

Reverse control supply switch as in part 2.

PART 4
Control M/C.B In Cab Is Found Tripped

If M/C.B. trips immediately it is reset, try other controller other end.
If M/C.B. trips on operation of control wheel try other controller, other end.
If M/C.B. is found set but no power on control wheel try other controller, other end.
PART 5

Locomotive Fails In One Direction Only

Operate control wheel and reverse lever and listen for reversers to throw.
   Reversers not heard to throw, operate manually No.2 cabinet.
   Try other control wheel.

PART 6

Locomotive Fails In Both Directions Fault Light Notch 1.

Press overload reset.
   Try overload reset other end.
   Loco. still fails check control air.
   Control air OK examine Main overload No.1 Motor overload
   No.2, 3, 4, in No.1 cabinet.
   Also Resist, blower overload 5 and 6 No.2 cabinet.
   If Main overload trips three times all other overloads OK get assistance.
   Motor overloads tripping manually reset — isolate motors pair by pair.
   Resistance, blowers overload tripping — isolate blowers.
   If overloads Nos. 1 and 2 cabinets OK but loco will not move operate E. P. valves to F, FF, B, X and Y switches, these switches must be in their L hand position.

PART 7

Locomotive Fails In Both Directions Fault Light Notch 2.

Examine main isolator switch No.1 cabinet.
   If OK isolate motors pair by pair.
   Still no result get assistance.
   Burnt or broken grids.
   If the loco. fails — No fault light — Trip Penalty Brake.

PART 5, 6 and 7

When in multiple use sound loco to clear section.

Voltage Regulator Failure:

Multiple Unit

Reverse control switch No.4 cabinet from normal to emergency on defective loco.
## SPEED CONVERSION CHART

### MILES - KILOMETRES

or miles per. hour - kilometres per. hour.

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"C" class

501 - 510
GENERAL DATA

Model Designation ........................................ GT26C
Locomotive Type ............................................. (C-C) 0660
Locomotive Horsepower ................................. 3000 - (2237 Kw)

Diesel Engine
Model ................................................................. 645E3
Type ................................................................. Turbocharged
Number of Cylinders .......................................... 16
Cylinder Arrangement ........................................ 45° “V”
Cylinder Bore and Stroke ................................. 9-1/16” x 10”
Operating Principle ...................................... 2 Stroke Cycle,
                             Turbocharged, Unit
                             Injection, Water Cooled
Full Speed ...................................................... 900 RPM
Idle Speed ........................................................ 315 RPM

Main Generator Model .................................. AR10-D14
Traction Alternator (Rectified Output) .............. AR10
   Number of Poles ........................................... 10
   Nominal Voltage (DC) ................................. 600
   Frequency (At 900 RPM) .............................. 75 Hz
Companion Alternator .................................... D14
   Nominal Voltage (AC) ................................. 180
   Number of Poles ........................................... 16
   Frequency (At 900 RPM) .............................. 120 Hz

Auxiliary Generator
Voltage (DC) .................................................... 74
Rating ............................................................. 10KW

Traction Motors
Model ............................................................ D77
Number ............................................................ 6
Type .............................................................. DC, Series Wound, Axle Hung

Driving Wheels
Number ............................................................ 6 Pair
Diameter .......................................................... 40”
Gear Ratio ......................................................... 59:18
Top Speed ....................................................... 82 mph (133 Km/h)
Speed at Continuous Rating ......................... 14.6 mph (23.4 Km/h)
Continuous Tractive Effort ......................... 65,000 lbs (289 Kn)
Air Compressor
  Type W.B.O. ......................................... Gardner Denver 2 Stage
  Number of Cylinders .................................. 3
  Capacity (At 900 RPM) .................................. 254 Cu. Ft./Min.
  Air Compressor Cooling ................................ Water (7.19 Cu.m.)
  Lube Oil Capacity ...................................... 2.75 Gal. (12.51 litres)

Storage Battery
  Number of Cells ......................................... 32
  Voltage .................................................. 64
  Rating (5 Hour) ......................................... 300 Amp Hr.

Supplies
  Lubricating Oil Capacity ............................... 202 Gal. (918 Litres)
  Cooling Water Capacity ................................. 246 Gal. (1118 Litres)
  Fuel Capacity .......................................... 2228 Gal. (10138 Litres)
  Sand ..................................................... 12 Cu. Ft. (36 Cu. m.)

Air Brakes ................................................. Type 261

Approximate Weight on Rails .......................... 132 Tons (134.15 Tonnes)

Weight on Drivers ........................................ 100%

Major Dimensions
  Length over Headstocks ................................. 64'3" (19.583 m.)
  Width over Underframe ................................ 9'9" (2.968 m.)
  Overall Height – Top of Rail to Top of Exhaust Stack ........................ 13'11" (4.242 m.)

Minimum Curve Radius ................................... 274 Ft. (82.2 m.)
SECTION 1
GENERAL DESCRIPTION

INTRODUCTION

The Model GT26C locomotive, is equipped with a turbocharged diesel engine that delivers 3000 horsepower (2237 Kw) to the main generator for tractive purposes. This power is then distributed to six traction motors, each of which is directly geared to a pair of driving wheels.

The basic locomotive is arranged and equipped so that the short hood or cab end is considered the front or forward part of the unit. However, the locomotive operates equally well in either direction.

The locomotive may consist of one or more individual units, each of which is a completely functional power plant. When coupled together for multiple unit operation, all can be simultaneously controlled from a single set of controls located in the cab of the lead unit. This is accomplished through jumper cables connected between the units.

A general arrangement of the locomotive is attached at the back of this manual. Each of the more important equipment components is numbered and identified.

HOW THE LOCOMOTIVE OPERATES

1. The fuel pump is driven by an electric motor which, for fuel priming, uses current from the storage battery. Once the engine is started and running, the fuel pump motor uses current directly from the auxiliary generator. The fuel pump transfers fuel from the fuel tank under the locomotive to the engine injectors.

2. The diesel engine is started by means of two parallel connected 64-volt cranking motors that engage the flywheel ring gear when starting current is applied. The storage battery supplies electric current to engage the starting pinions and rotate the cranking motors and to run the turbine lube oil soak back pump.

3. When the engine is running, it supplies mechanical power through shafts and couplings to directly drive three electrical generators, the air compressor, motor and generator blowers, and engine mounted lube oil and cooling water pumps.
4. The auxiliary generator charges the storage battery and supplies low voltage direct current for the control and lighting circuits. The companion alternating current generator furnishes power to the static exciter, various transducers, the three radiator cooling fans, and a dust evacuating blower. The main traction alternator supplies high voltage AC to a power rectifier assembly which then delivers high voltage DC to the traction motors.

5. By means of cab controls, low voltage circuits are established to actuate the engine governor and the switchgear in electrical cabinets. This switchgear controls generator excitation and distribution of power.

6. Six traction motors are located under the locomotive. Each traction motor is directly geared to an axle and pair of driving wheels. These motors are located in two trucks which support the locomotive weight and distribute it to the driving wheels.

7. The throttle electrically controls speed and power by actuating a governor mounted on the engine and by tying the response of the locomotive power control system to throttle position. The main generator converts the engine's mechanical power to electrical power, which is then distributed to the traction motors through circuits established by the various switchgear components in the electrical cabinet.

8. At locomotive start the throttle controls electrical devices that provide rapid power response at a level consistent with smoothly controlled starting.

9. At moderate and high operating speed a load regulator operates to maintain power output at the specific level called for by throttle position. This prevents the engine from being overloaded or underloaded. During heavy drag low speed operation power is controlled at a lower level within adhesion limits.

10. An additional power reduction feature which provides infinitely variable control of power for each throttle position, may be selected by operating a switch on the control panel and driver's control stand to apply on:
   (a) A single unit in a multiple consist.
   (b) On all units in a multiple consist.
11. The air compressor supplies, to the reservoirs, air under pressure used primarily for the air brakes. The air brakes are controlled by the operator through suitable equipment in the cab.

12. Except for manual operation of the cab controls, the locomotive operations is completely automatic. Various alarms and safety devices will alert the operator should any operating difficulties occur.
SECTION 2
ENGINE STARTING AND CAB CONTROLS

INTRODUCTION

A switch for fuel priming and engine cranking is located at the equipment rack in the engineroom. All other basic control equipment used during locomotive operation is at five locations within the cab.

1. The Switch And Fuse Panel
2. Circuit Breaker Panel
3. The Engine Control Panel
4. The Locomotive Control Stand
5. The Air Brake Pedestal

ENGINE STARTING CONTROLS

Fuel Prime And Engine Start Switch

This switch, located on the equipment rack in the engine room, is a three-position rotary switch used for fuel priming and engine starting. Before attempting to start the diesel engine, the isolation switch in the locomotive cab must be placed in the START position. The rotary switch in the engine room must then be placed in the FUEL PRIME position and held there for 10 to 15 seconds to operate the fuel pump and purge the fuel system of air. The layshaft lever must then be positioned and the rotary switch placed in the ENGINE START position and held (for no longer than 20 seconds) until the engine starts.

Layshaft Lever

This engine mounted hand operated lever operates the injector racks. It is used to position the injector racks during engine cranking, thereby providing an immediate supply of fuel to the cylinders.
CAB CONTROLS

Low Water Reset Pushbutton

The low water detector will often trip during engine starting, especially when the engine is cold or when the water tank pressure cap has been removed to add water. The detector should be reset as soon as the engine starts and is idling, or else the engine will shut down after a time delay established by the governor.

Check the low water reset pushbutton after every engine start.

NOTE: The reset buttons on some detectors will not latch in when the engine is shut down. If such a condition is encountered, reset the device after engine start.
GOVERNOR RACK POSITION

SCALE

LAYSHT LEVER
(Injector rack manual control)

ENGINE PROTECTOR
Press low water reset
After engine start

ENGINE STARTING CONTROLS
SWITCH AND FUSE PANEL

This panel is located within the electrical cabinet that forms the rear wall of the locomotive cab. Its position is directly below the engine control panel which is located in the upper right hand corner of the electrical cabinet.

D14 Alternator Field 60-ampere Fuse

The D14 alternator receives its excitation through a pair of slip rings connected to the low voltage DC auxiliary generator output. To protect these windings, a 60-ampere fuse is provided in the excitation circuit. This fuse must be good and in place at all times during locomotive operation. In the event that the fuse is blown, D14 alternator excitation and resulting power output will cease, giving an alternator failure light, alarm bell, and reduce the engine speed to idle.

Ground Relay Cutout Switch

The purpose of the ground relay cutout switch is to eliminate the ground protective relay from the locomotive circuits during certain shop maintenance inspections. IT MUST ALWAYS BE KEPT CLOSED in normal operation, otherwise the protection offered by the ground relay will be nullified and possible serious equipment damage could occur. It may be opened, however, in the event of extreme emergency upon receipt of definite instruction to that effect from a responsible officer of the railroad.

Fuse Test Equipment

To facilitate the testing of fuses, a pair of fuse test blocks, a test light and a test light toggle switch are installed on the fuse panel. Fuses may be readily tested as follows. First, move the toggle switch to the ON position to make sure the fuse test light is not burned out. Extinguish the light by moving the toggle switch to the OFF position. Place a fuse across the test blocks so that the metal ends of the fuse are in firm contact with the blocks. If the fuse is good, the light will come on. If the fuse is burned out, the light will not come on and a new fuse is required. It is always advisable to test fuses before installing them in their circuits. Always isolate the circuits in question by opening their switches before changing or replacing fuses.
1 TRACTION GEN. FIELD C.B. 6 GROUND RELAY CUT-OUT
2 DJ4 ALTERNATOR FIELD 60AMP FUSE 7 AUXILIARY GEN. 150AMP
3 FUSE TEST LIGHT 8 START 800AMP
4 FUSE TEST LIGHT SWITCH 9 MAIN BATTERY KNIFE SWIT
5 FUSE TEST TERMINALS
Auxiliary Generator Fuse

This fuse connects the auxiliary generator to the low voltage system. It protects against excessive current demands. A 150 ampere fuse is installed for the auxiliary generator. In the event that the fuse is burned out, it stops auxiliary generator output to the low voltage system and also stops fuel pump operation. An alternator failure (no power) alarm would then occur. The engine will go to idle speed and finally stop from lack of fuel.

Starting 800-ampere Fuse

The starting fuse is in use only during the period that the diesel engine is actually being started. At this time, battery current flows through the fuse and starting contactor to the cranking motors.

Although this fuse should be in good condition and always left in place, it has no effect on locomotive operation other than for engine starting. A defective fuse can be detected when attempting to start the engine, since at that time (even though the starting contactors close) the cranking circuit is open.

Main Battery Knife Switch

The large double-pole single-throw knife switch at the lower portion of the fuse panel is the main battery switch. It is used to connect the battery to the locomotive low voltage system and should be kept closed at all times during operation.

This switch may be opened during certain shop maintenance procedures and in instances where the engine is shut down and the locomotive taken out of service for an extended layover. This will prevent the battery from being discharged in the event the lights or other low voltage devices are inadvertently left operating during the layover. Particular attention should be given to a notation at the switch which cautions against opening the switch immediately after engine shutdown. At least 35 minutes should be allowed following engine shutdown before this switch is opened after load operation at or above throttle position No. 3. That is, cool down time for the turbocharger bearings can be considered to accumulate below throttle position No. 3 even though the 35 minute timing of the turbocharger auxiliary lube oil pump begins at engine shutdown.
AR10 Generator Field 100-ampere Circuit Breaker

The AR10 generator receives its excitation through a pair of slip rings connected to the D14 alternator output through a controlled rectifier. The circuit breaker is provided to protect the controlled rectifier and the generator field windings.

NOTE: When circuit breakers trip, the trigger moves to mid position. To reset move the trigger all the way to OFF then move to ON.

CIRCUIT BREAKER PANEL

This panel is located in the fuse cabinet above the fuse panel.

Lights 30-ampere Circuit Breaker

This circuit breaker must be ON to supply power for the individual switches provided for cab, step, engine room, class and ground and gauge lights.

Headlight 30-ampere Circuit Breaker

This circuit breaker must be ON to supply current to headlights which are further controlled by selector switches on the control stand.

Local Control 30-ampere Circuit Breaker

This circuit breaker must be in the ON position before operation of the locomotive is possible. During operation it establishes "local" power from the auxiliary generator to operate heavy duty switchgear, and various control devices.

Control 40-ampere Circuit Breaker

This circuit breaker must be in the ON position before locomotive operation is possible. It sets up the fuel pump and control circuits for engine starting. Once the engine is running, power is supplied through this breaker from the auxiliary generator to maintain operating control.
CAB CONTROLS

Auxiliary Generator Field 15-ampere Circuit Breaker;

The field excitation circuit of the auxiliary generator is protected by a 15-ampere circuit breaker. This circuit breaker must be ON at all times during locomotive operation.

In the event that the circuit breaker is tripped it will stop auxiliary generator output to the low voltage system and will also stop fuel pump operation. An alternator failure (no power) alarm would then occur. The engine will return to idle speed and finally stop from lack of fuel.

Fuel Pump 15-ampere Circuit Breaker

The fuel pump circuit breaker must be ON for normal operation.

Turbo Pump Motor 30-ampere Circuit Breaker

This circuit breaker must be in the ON position to start the engine and operate the turbocharger auxiliary lube oil pump. It must remain in the ON position to provide auxiliary lubrication to the turbocharger at engine start and after the engine is shut down. A guard is provided over this breaker switch to prevent accidental movement to the OFF position.

Miscellaneous Circuit Breakers

Circuit Breakers are included for water cooler (15-amp), cab heaters and hotplate, (40-amp). The circuit breakers should be placed in the ON position to obtain the desired operation.

Test Jacks

The cabinet mounted test jacks are located in the high voltage system. When telephone plugs or 7/32" metal rods are inserted in the jacks, various relay voltage coils are disconnected from the main generator. This enables calibration of circuits through the use of a fixed voltage from an MG set.

CAUTION: High voltage is present at the test jacks during locomotive operation.

ENGINE CONTROL PANEL

The engine control panel is located at the upper right hand corner of the electrical cabinet that forms the rear wall of the cab. This panel contains various switches and alarm lights, along with a battery charging meter. Since all of these items will be used at one time or another during operation, a brief description of their individual functions is provided.
Note that an alarm bell accompanies alarm signal light indications. The bell will ring in all units of a locomotive consist, but the light will come on only in the affected unit.

**Battery Charging Meter**
With the main battery knife switch closed, the battery charging ammeter is connected into the low voltage circuits to indicate the extent of current flowing to and from the storage battery. This meter does not indicate the output of the auxiliary generator. The ammeter may show a high charge immediately after starting but should reduce to zero and in normal running should read zero or show a slight charge.

A very strong discharge at time of engine shutdown, followed by blown fuses, indicates a shorted battery charging rectifier. When a very strong discharge is indicated, exercise care opening the main battery switch.

**Alternator Failure Light (Red)**
The alternator failure light will come on, and the alarm bell will ring any time the no AC voltage relay (NVR) opens with the isolation switch in RUN position and the ER switch in On position. This will occur if the engine stops for any reason or if D14 alternator failure occurs during operation.

**Turbocharger Auxiliary Pump Motor Light (Blue)**
This light will come on as soon as the main battery switch and turbo lube pump circuit breaker are closed. It indicates that the turbocharger auxiliary lube oil pump is supplying lube oil to the turbocharger. It will remain on for approximately 35 minutes after the main battery switch is closed. When the fuel prime engine start switch is operated after the 35 minute period, the time cycle is again re-established and the light remains on for another 35 minutes.

The light will also come on and remain on for approximately 35 minutes after the engine is stopped to provide an indication that the auxiliary lube oil pump is supplying oil to cool the turbocharger bearings.

**Excitation Limit Light (Amber)**
An electrical system relates generator excitation to main generator output and acts to hold power at an acceptable level during various temporary conditions of locomotive operation. Should this system lose calibration or somehow fail, there would be no protection against abnormally high generator current.
CAB CONTROLS

An excitation limit relay senses high current and acts to protect against it. When this action occurs, the excitation limit light comes on, the alarm rings, the engine goes to idle speed, and the main generator loses excitation. Power can be recovered if the throttle is returned to idle position and reopened. However, if the fault persists, the excitation limit light will again come on, and power will be lost.

Manual Power Control Selector Switch

Infinitely variable control of power in each throttle position may be selected to apply on a Single or Lead Unit or on all units of a multiple consist by placing the Manual Power Control Selector in “Lead Only” or “All Units” position respectively.

A switch on the driver’s control stand completes the circuit to bring this feature into operation when required. A manual power control indicator on the control stand shines when the switch is ON and the throttle is opened. A rheostat on the control stand may then be used to make fine adjustments in power to control wheel slip while maintaining full traction motor and main generator cooling or alternatively provide a means of slow speed train control.

Engine Stop Pushbutton

The diesel engine will stop whenever the engine stop pushbutton is pressed. The reaction to the pushbutton is immediate, it need not be held in until the engine stops.

CAUTION: The main battery switch and the turbocharger circuit breaker must remain closed for 35 minutes when the engine stops after operation at throttle position No. 3 or higher.

Engine Start Switch Legend

The fuel prime/engine start switch is located on the equipment rack in the engineroom, (see Engine Starting Controls P. 13) This location allows the operator to manipulate the engine layshaft lever during engine cranking, thereby facilitating faster starting with less drain on the locomotive battery.
Isolation Switch

The isolation switch has two positions, one labelled START, the other labelled RUN. The functions of these two positions are as follows:

1. START Position

   The isolation switch is placed in this position whenever the diesel engine is to be started. The start switch is effective only when the isolation switch is in this position.

   The START position is also used to isolate the unit, and when isolated the unit will not develop power or respond to the controls. In this event the engine will run at idle speed regardless of the throttle position. This position will also silence the alarm bell in the event of an excitation limit, ground relay, alternator failure or engine protector alarm. It will not, however, stop the alarm in the event of a hot engine. Vigilance is also suppressed with the isolation switch in START.

2. RUN Position

   After the engine has been started, the unit can be placed “on the line” by moving the isolation switch to the RUN position. The unit will then respond to control and will develop power in normal operation.

LOCOMOTIVE CONTROLLER

The locomotive controller contains the switches, gauges and operating levers used by the operator during operation of the locomotive. The individual components of the controller are described, together with their functions, in the following paragraphs.

Air Gauges

Air gauges indicating main reservoir, equalising reservoir, brake pipe, and brake cylinder pressures and a brake pipe flowmeter are prominently located along the top of the controller.

Load Current Indicating Meter

The Locomotive pulling force is indicated by the load current indicating meter. This meter is graduated to read amperes of
electrical current, with 1500 being the maximum reading on the scale.

The meter is connected so as to indicate the current flowing through the No. 3 traction motor. Since the amperage is the same in all motors, each motor will carry the amount shown on the meter. Since the traction motors receive the power from the main generator, the meter readings may be multiplied to determine the approximate generator current output. The multiplying factor will depend, however, on the particular transition circuit in effect at the time the reading is taken. For example, when operating in a series-parallel circuit, the multiplying factor is 3; in parallel it is 6.

Thus a meter reading of 200 amperes would indicate a generator output of 600 amperes when operating in series-parallel or alternatively 1200 amperes in parallel.

On locomotives equipped with dynamic brakes, the load current indicating meter indicates braking effort during operation of dynamic brakes. Since the dynamic brake regulator controls maximum braking current, the meter should seldom if ever indicate more than 700 amperes. This is the rating of the dynamic braking resistor grids.

Indicating Lights

Indicating lights are installed to provide a visual warning of operating difficulties. The functions of these lights are as follows:

1. **Hot Engine Light (Red)**

   When engine water temperature reaches 208°F (97°C), the alarm will ring and the light will shine.
   Isolate engine and investigate cause.
   Check water level.
   All radiator shutters should be open and three radiator cooling fans running.
   Light goes out and bell stops ringing when engine water temperature drops to 198°F (91.3°C).

   **CAUTION:**
   Should it be necessary to remove the pressure cap from the header tank extreme care should be taken to turn the cap slowly. The cap should NOT be removed while the hot engine alarm is ringing.
2. **Ground Relay Light (Red)**

This light indicates that a high voltage ground fault or a phase unbalance to the A.C. Windings in the A.R.10 alternator has occurred.

The Ground Relay (GR) is energised and held in by a mechanical latch.

Generator field excitation is lost, engine speed is reduced to idle and the alarm bell sounds in all units in a multiple consist. The GR light will be on only in the defective unit.

**To Reset**

Return throttle to idle and reset by pressing the GROUND RESET button adjacent to the light.

Proceed with normal operation.

Should the alarm bell ring for the third time after using the GROUND RESET button twice the affected unit should be isolated (isolation switch in START). Failure to observe this procedure could result in severe damage to the A.R.10 alternator. The routine procedure established by the railroad should be used to report the light indication and alarm but no action should be taken to cancel a small enunciator light on the Ground Relay. This light should be reset by maintenance personnel only.

**NOTE:** The Ground Relay does not indicate ground faults in the low voltage circuits.

3. **Wheel Slip Light (Red)**

Intermittent flashing of the wheel slip light indicates that the wheel slip control system is doing its job and is correcting the slips. The throttle and locomotive power need not be reduced unless severe lurching threatens to break the train.

**When wheel slip occurs—**

- Power to the traction motors is automatically reduced.
- Wheel slip light shines.
- Sand is applied automatically (provided the Auto Sand Switch is ON).
- After 5 to 8 seconds sanding stops.
- Full power is re-applied gradually when wheel slip stops.
If wheel slip light flashes repeatedly—and train surging occurs reduce power by operating the manual power control or by reducing throttle.

If the light persists. This may indicate a pair of sliding wheels or a circuitry fault. Check by stopping the train then start slowly with an observer on the ground to check that all wheels are rotating. If wheels are locked notify the locomotive depot and do not attempt to move the locomotive.

Wheel Creep
The early stages of Wheel slip.
Power to traction motors is slightly reduced. Indicator light will not shine. Sand will be supplied automatically (provided Auto Sand switch is ON).

After 5-8 seconds sanding stops.

Sand Button
A foot-operated sanding switch is located on the floor adjacent to the driver’s control stand and is provided to operate the sanding magnet valves manually.

To test operation of sanders.
With—
Main air reservoir charged.
Battery knife switch CLOSED.
Control circuit breaker ON.
Control and fuel pump switch ON.
Place reverser in FORWARD or REVERSE.
Press foot sanding button.
Observe the discharge of sand.

4. Brake Warning Light (Red)
A brake warning light is installed on units equipped with dynamic brakes and functions in conjunction with a brake warning relay. The purpose of the relay and light is to indicate excessive braking current when operating in dynamic braking.

Due to the use of an automatic brake limiting regulator, the
warning light should seldom if ever come on and then only momentarily. Correction for excessive current generally occurs automatically and quite rapidly.

In the event that the brake warning light comes on and does not go out quickly, the braking current should be immediately reduced to prevent possible equipment damage. Excessive braking current can be reduced by moving the throttle toward idle position.


The Manual power control light will shine when the manual power control switch on the control stand is placed ON and the throttle is opened.

A manual power control rheostat on the front of the control stand may then be used to make fine adjustments in power below that normally provided in the throttle notch being used in conjunction with the manual power control feature at the time.


A mechanism to detect low engine lubricating oil pressure is built into the engine governor.

This mechanism is actuated by true oil pressure failure or by dumping oil from the engine oil line leading to the governor. In either event a small button will pop out of the governor body, indicating that the mechanism has tripped the low oil alarm switch. The red light on the engine control panel will come on to indicate that the low oil mechanism has tripped. When a Crankcase (Oil Pan) Pressure/Low Water/Low Oil alarm occurs it is necessary to determine whether the crankcase pressure—low water detector has tripped to dump engine oil from the line leading to the governor or whether a true oil failure has occurred. This can be determined by checking the crankcase pressure — low water detecting device, at the governor end of the engine for protruding reset buttons. A protruding upper button indicates excessive oil pan pressure; a protruding lower button indicates low water.

NOTE: The reset buttons on some detectors will not latch in while the engine is shut down, and on some detectors the button will trip at engine start. Always check and press the reset button immediately after starting the engine.

In a multiple consist the alarm sounds in all units. The light shines only in the defective unit.
7. Ground Reset Button

This button, located on the left hand top corner of the control stand resets the ground relay as explained under “Ground Relay Light”.

Operating Switches

A group of switches is located along the front face of the controller, each identified by a name plate indicating switch function. The switches are in the ON position when moved upward.

Before the engine is to be started, the control and fuel pump switch must be placed ON. To obtain power from the locomotive, the generator field switch must be ON and brake pipe pressure must be in excess of 56 p.s.i. (386 Kp) the pick up value of the D.P.C. (Dynamic Pneumatic Contactor).

To obtain control of engine speed, the engine run switch must be ON. These three important switches are grouped at the right side of the controller. They must be placed in the OFF position on controllers of trailing units.

Other switches control automatic sanding, manual power control and various lights. They are placed on as needed.

Headlight Control Switch

A four position switch is located on the controller below the load meter. In one position it provides for DIM headlights on both ends of the locomotive. In the other two positions it provides for a DIM headlight at either the front or the rear of the locomotive. The fourth position is OFF.

For this switch to function, the headlight circuit breaker on the switch and fuse panel must be placed ON. In addition a “headlight bright” switch on the controller gives bright headlights as selected by the four position switch.

CONTROLLER
DYNAMIC BRAKE HANDLE

The dynamic brake handle is located in the upper portion of the controller panel. The position of the dynamic brake handle determines the amount of braking effort applied to the locomotive through the traction motors. With the directional handle
CAB CONTROLS

in either forward or reverse position and the throttle in IDLE the dynamic brake can be positioned from the OFF position to the "notched" SETUP position, and then to the "unnotched" positions of 1 through FULL 8 to control the braking rheostat. Each of the positions is shown in the illuminated indicator above the brake handle.

Throttle Handle

The throttle handle is located in the centre portion of the controller panel. Movement of the throttle handle causes rotation of a cam drum which actuates roller switches to excite the main generator field and to establish low voltage circuits to the engine governor for the purpose of controlling engine speed and power.

The throttle has nine "notched" positions, from the far right of IDLE through the running speeds of 1 through 8 at the far left position. There is also a STOP position which can be obtained by pulling the handle outward in the IDLE position and moving the handle to the full right position over the escutcheon detent. Placing the throttle in STOP shuts down all engines in a locomotive consist. Each of the positions is shown in the illuminated indicator above the throttle handle.

Directional Handle

The directional handle is located in the lower portion of the controller panel and controls the direction in which the locomotive moves. The handle has three positions: right of centre, centre position, and left of centre. The locomotive will move in the direction in which the handle is positioned. With the handle in the centre position no tractive effort will be developed if the throttle is opened. The directional handle should be moved only when the locomotive is not in motion.

The directional handle on a locomotive controller also functions as a key to lock the mechanism when the handle is removed and to unlock when handle inserted. The directional handle can be removed from the controller only when the handle is in the centre position, the throttle is in IDLE, and the dynamic brake is in OFF.

Alteration of a directional handle to make the handle easier to insert or remove is a HIGHLY DANGEROUS practice. Such alteration can affect the ability of the handle to engage the locking mechanism of the controller.
Interlock Mechanism

The interlock mechanism is located in the lower portion of the controller. The throttle axle and dynamic brake axle each have a metal cam plate, the lobes and notches of which interact with pivoted rollers and the handle carrier cam plate to provide the necessary mechanical interlocking. This interlock inhibits the movement of an operating handle unless the other handles are in a position where the subject handle can be safely operated. An interlock override provision allows the throttle to be moved from IDLE to STOP position anytime the directional handle is inserted in the controller.

1. Directional handle removed.
   a. Throttle locked in IDLE.
   b. Dynamic brake locked in OFF.

2. Directional handle installed and centered.
   a. Throttle can be moved to any position.
   b. Dynamic brake locked in OFF.

3. Directional handle installed and in either forward or reverse.
   a. Dynamic brake in OFF.
      --Throttle can be moved to any position.
   b. Dynamic brake in any position from SETUP to FULL 8.
      --Throttle can be moved between IDLE and STOP only.
   c. Throttle in IDLE or STOP.
      --Dynamic brake can be moved to any position.
   d. Throttle in any position from 1 to FULL 8.
      --Dynamic brake locked in OFF.

4. Throttle handle in IDLE or STOP.
   a. Directional handle installed and centered.
      --Dynamic brake locked in OFF.
   b. Directional handle installed and in either forward or reverse
      --Dynamic brake can be moved to any position.
   c. Dynamic brake in OFF.
      --Directional handle can be moved to any position.
   d. Dynamic brake in any position from SETUP to FULL 8.
      --Directional handle locked in either forward or reverse.

5. Throttle handle in any position from 1 to 8.
   a. Dynamic brake locked in OFF.
   b. Directional handle is locked in either forward, centre, or reverse.
6. Dynamic brake handle in OFF.
   a. Directional handle installed and in forward, centre, or reverse.
      -Throttle can be moved to any position.
   b. Throttle in any position from 1 to 8.
      -Directional handle locked in either forward, centre, or reverse.

7. Dynamic brake in any position from SETUP to FULL 8.
   a. Throttle can be moved between IDLE and STOP only.
   b. Directional handle locked in either forward or reverse.

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DYNAMIC BRAKE

THROTTLE

REVERSER

CONTROLLER
SECTION 3
OPERATION

INTRODUCTION
This section of the manual covers recommended procedures for operation of the locomotive. The procedures are briefly outlined and do not contain detailed explanations of equipment location or function.

The information in this section is arranged in sequence, commencing with inspections in preparation for service, and with instructions for starting the engine, handling a light locomotive, coupling to train, and routine operating phases. The various operating situations and special features such as dynamic braking are also covered.

PREPARATION FOR SERVICE

GROUND INSPECTION
Check locomotive exterior and running gear for:
1. Leakage of fuel oil, lube oil, water or air.
2. Loose or dragging parts.
3. Proper hose connections between units in multiple.
4. Proper positioning of all angle cocks and shut-off valves.
5. Air cut-in to truck brake cylinders.
6. Satisfactory conditions of brake shoes.
7. Adequate supply of fuel.
8. Proper installation of control jumper cables between units.

LEAD UNIT CAB INSPECTION
On the lead or control unit, the control locations described in Section 2 should be checked and the equipment positioned for operation as follows:

Fuse and Switch Panel
1. Main battery switch closed.
2. Ground Relay knife switch closed and sealed.
3. All fuses installed and in good condition. Particular attention should be paid to the generator field 100-amp circuit breaker. This should be placed ON.
OPERATION

Circuit Breaker Panel
1. Control and Local Control Circuit Breakers ON.
2. Auxiliary Generator Field Circuit Breaker ON.
3. Fuel pump and turbo lube pump circuit breakers ON.
4. Lights circuit breakers and miscellaneous circuit breakers ON as needed.

Engine Control Panel
1. Isolation switch in START position.
2. Manual Power Control switch positioned to give manual control of power on lead unit only or all units in a multiple consist as desired.

Locomotive Controller
The controller switches and operating levers should be positioned as follows:
1. Place control and fuel pump switch in ON (up) position.
2. Place engine run switch ON (up) position.
3. Make sure throttle remains in IDLE position and reverse lever is removed from controller.

Air Brakes — Type 26L
1. Insert automatic brake valve handle (if removed) and place in RELEASE position.
2. Insert independent brake valve handle (if removed) and move to FULL APPLICATION position.
3. Position cutoff valve to IN POSITION.
4. Place MU valve in LEAD position.

ENGINE ROOM INSPECTION
The engine can be readily inspected by opening the access doors along the sides of the long hood end of the locomotive.
1. Check air compressor for proper lubricating oil supply.
2. Observe for proper water level on tank sight glass.
3. Check all valves for proper positioning.
4. Observe for leakage of fuel oil, lubricating oil, water or air.

ENGINE INSPECTION
The engine should be inspected before as well as after starting. After inspection and engine start, all engine room doors should
OPERATION

be closed and latched securely, as engine room is pressurized during operation.

1. Check to see that engine overspeed lever is set.

2. Observe that governor oil pressure trip button is set and that there is oil visible in the governor sight glass.

3. Observe that the crankcase (oil pan) pressure and low water detector reset buttons are set (pressed in). If the buttons protrude, press and hold for 5 seconds immediately after engine starts.

4. Observe that engine top deck, air box and oil pan inspection covers are in place, and are securely closed.

STARTING THE DIESEL ENGINE

After the preceding inspection has been completed, the diesel engine may be started. Starting controls are located at the accessory end of the engine in the area of the equipment rack.

Perform the following:

1. Observe railroad regulations regarding barring over the engine before cranking the engine. If any doubt exists that the engine is not free to rotate it should be barred-over.

2. Place the fuel prime/engine start switch in the FUEL PRIME position and hold until the return fuel sight glass (nearest to the engine) is full and clear. This primes the fuel system and purges air from the fuel.

3. Position the layshaft lever at about one third rack then move the fuel prime/engine start switch to ENGINE START pos-
OPERATION

Release the layshaft as soon as engine speed increases and governor control of the linkage is felt at the lever. Do not over rev the engine.

Do not crank the engine for short repeated intervals to turn an engine over. Such cranking can overheat and destroy starting components.

If the engine does not start after 20 seconds of free cranking, release the starting switch. Allow 2 minutes between cranking attempts. This will allow the cranking motors to cool.

4. Check that engine oil pressure, engine oil level, and governor oil level are satisfactory. Immediately after engine starts check reset buttons on detector and hold in for 5 seconds if needed.

5. Check that the engine cooling water level does not fall below the “LOW” mark on the “Engine Running” portion of the water level gauge plate. If the water level is slightly low, the engine may continue to run at idle speed, but may shut down when the throttle is advanced.

TRAILING UNIT CAB INSPECTION

Switches, circuit breakers and control equipment located in the cab of a trailing unit should be checked for proper positioning as follows:

Fuse and Switch Panel
1. All knife switches closed.
2. All fuses installed and in good condition.

Circuit Breaker Panel
1. Control and Local Control Circuit Breakers ON.
2. Auxiliary Generator Field Circuit Breaker ON.
3. Fuel pump circuit breaker ON.
4. Turbo lube pump circuit breaker ON.

Engine Control Panel
1. Isolation switch in START position.
2. Vigilance Unit Selector switch in TRAIL.

   NOTE: Manual Power Control Switch on trailing units does not affect locomotive operation.

**Locomotive Controller**

The controller switches and operating levers should be positioned as follows:

1. Control and fuel pump switch, generator field switch, and engine run switch must be OFF.

2. Throttle in IDLE.

3. Selector lever in OFF.

4. Reverse lever placed in neutral and then removed from the controller to lock the other levers.

**Air Brakes – Type 26L**

1. Place automatic brake valve handle in HANDLE OFF position and remove handle.

2. Place independent brake valve handle in FULL RELEASE position and remove handle.

3. Place MU valve in TRAIL 6 or 26 position.

4. Place cutoff valve in OUT position.

**STARTING TRAILING UNIT DIESEL ENGINES**

Engines in trailing units are started in the same manner as the engine in the lead unit.

**PLACING UNITS ON THE LINE**

After the diesel engines are started and inspected, units may be placed on the line as desired by placing the isolation switch on the engine control panel in the cab in the RUN position. If the consist is at a standstill, be certain that the throttle lever in all units is in the idle position before placing any unit on the line. This can be checked by noting that there is no load meter reading when the isolating switch is placed in RUN position.
OPERATION

PRECAUTIONS BEFORE MOVING LOCOMOTIVE

The following points should be carefully checked before attempting to move the locomotive under its own power:

1. **MAKE SURE THAT MAIN RESERVOIR AIR PRESSURE IS NORMAL** (approximately 120 pounds, 827 Kp).
   The locomotive can not be powered until brakepipe pressure exceeds 56 p.s.i. (386 Kp). This is the pick up value of the Dynamic Pneumatic Contactor (DPC).

2. Check for proper application and release of air brakes.
3. Release hand brake and remove any blocking under the wheels.

HANDLING LIGHT LOCOMOTIVE

With the engine started and placed “on-the-line” and the preceding inspections and precautions completed, the locomotive is handled as follows:

1. Check that the manual power control switch is OFF if not required.
2. Place the generator field switch in ON (up) position.
3. Place headlight and other lights ON as needed.
4. Insert reverse lever and move it to desired direction of travel, either forward or reverse.
5. Release air brakes.
6. Open throttle to Run 1, 2 or 3 as needed to move locomotive at desired speed.
7. Throttle should be in IDLE before coming to a dead stop.
8. **REVERSE LEVER SHOULD BE MOVED TO CHANGE DIRECTION OF TRAVEL ONLY WHEN LOCOMOTIVE IS COMPLETELY STOPPED.**
STARTING A TRAIN

The method to be used in starting a train depends upon many factors such as, the type of locomotive being used; the type, weight and length of the train and amount of slack in the train; as well as the weather, grade and track conditions. Since all of these factors are variable, specific train starting instructions cannot be provided and it will therefore be up to the operator to use good judgement in properly applying the power to suit requirements. There are, however, certain general considerations that should be observed. They are discussed in the following paragraphs.

A basic characteristic of the diesel locomotive is its HIGH STARTING TRACTIVE EFFORT. Neglecting manual power control this is DIRECTLY RELATED TO THROTTLE POSITION. The design of the locomotive power control system is such that tractive effort is low in low throttle position and high in high throttle position, and this effort is available immediately as the throttle is positioned. These characteristics make the use of independent locomotive brakes or the manipulation of the throttle between run 1 and idle generally unnecessary during starting.

The available tractive effort does however make it imperative that the air brakes be completely released before any attempt is made to start a train. On an average 100 car freight train having uniformly distributed leakage, it may take 10 minutes or more to completely release the brakes after a reduction has been made. It is therefore important that sufficient time be allowed after stopping, or otherwise applying brakes, to allow them to be fully released before attempting to start the train.

The locomotive possesses sufficiently high tractive effort to enable it to start most trains without taking slack. The practice of taking slack indiscriminantly should thus be avoided. There will, however, be instances in which it is advisable (and sometimes necessary) to take slack in starting a train. Care should be taken in such cases to prevent excessive locomotive acceleration which will cause undue shock to draft gear and couplers, and lading.
OPERATION

Proper throttle handling is important when starting trains, since it has a direct bearing on the power being developed. As the throttle is advanced, a power increase occurs almost immediately, and power applied is at a value dependent upon throttle position. It is therefore advisable to advance the throttle one notch at a time when starting a train. A train should be started in as low a throttle position as possible, thus keeping the speed of the locomotive at a minimum until all slack has been removed and the train completely stretched. Sometimes it is advisable to reduce the throttle a notch or two at the moment the locomotive begins to move in order to prevent stretching slack too quickly or to avoid slipping.

When ready to start, the following general procedure is recommended:

1. Move reverse lever to the desired direction, either forward or reverse.
2. Place generator field switch in the ON (up) position.
3. Release both automatic and independent air brakes.
4. Open the throttle one notch at a time. In Notch 1, the engine will quickly load but unloading will remain at a specific low value as will be noted on the load indicating meter.

   Notches 2, 3 or higher may be selected until the locomotive moves the train. Avoid high load meter readings with the locomotive stationary. This can result in damage to the traction motor commutators. Either increase the current to start the train moving or return the throttle to idle to check for sticking brakes on the locomotive and train.

5. After the train is stretched, advance the throttle as desired. Alternatively the train may be started using the manual power reduction feature as follows:

   (1) Proceed with steps 1 to 3 above.
   (2) Turn manual power control toggle switch on the control stand ON.
   (3) Turn the manual control rheostat to MIN position and open the throttle to a notch which from experience will normally start and accelerate the train (usually notch 4 or 5 — higher notches may be used if required).
   (4) Turn the manual control rheostat gradually towards MAX to cause the train to move and accelerate.
(5) Reduce the rheostat slightly towards MIN if wheel slip occurs.

When the rheostat has been turned all the way to MAX with throttle in Notch 4 or 5 the train will normally be moving freely and there will be no advantage in continuing to use the manual power control feature. The manual power control may then be switched OFF and the throttle advanced in the usual way.

When operating at full power on an ascending grade the wheel slip light may indicate slipping. In this case it will be an advantage to reduce power slightly using the manual power reduction feature as follows:

(1) Turn the manual power control rheostat to MAX position.

(2) Turn manual power control toggle switch on the control stand ON.

(3) Adjust the manual power control rheostat and reduce power sufficient to prevent slipping.
The load indicating meter provides the best guide for throttle handling when accelerating a train. By observing this meter it will be noted that the pointer moves toward the right (increased amperage) as the throttle is advanced. As soon as the increased power is absorbed, the meter pointer begins moving toward the left. At that time, the throttle may again be advanced. Thus for maximum acceleration without slipping, the throttle should be advanced one notch each time the meter pointer begins moving toward the left until full power is reached in throttle position 8. Additional train acceleration is provided by changing motor connections with the main generator (forward transition) from three groups of two motors in series to six motors in parallel. This change of electrical circuits takes place automatically without any attention or action required on the part of the operator.

SLOWING DOWN BECAUSE OF A GRADE

When starting to climb a hill, the locomotive and train will slow down and the increased load will be indicated by load indicating meter pointer movement toward the right. Backward transition will take place automatically.

OPERATING OVER RAIL CROSSING

When operating the locomotive at speeds exceeding 25 MPH, (40 Kph), reduce the throttle to a RUN 4 position at least eight seconds before the locomotive reaches a rail crossing. If the locomotive is operating in RUN 4 position or lower, or running less than 25 MPH (40 Kph), allow the same interval and place the throttle in the next lower position. Advance the throttle after all units of the consist have passed over the crossing. This procedure is necessary to ensure decay of motor and generator voltage to a safe level before the mechanical shock that occurs at rail crossings is transmitted to the motor brushes.

RUNNING THROUGH WATER

Under ABSOLUTELY NO CIRCUMSTANCES should the locomotive be operated through water deep enough to touch the bottom of the traction motors. Water any deeper than 3" (76mm) above the rail is likely to cause traction motor damage. When passing through any water on the rails, exercise every precaution under such circumstances and always go very slowly, never exceeding 2 to 3 MPH (3 to 4 Kph).
WHEEL SLIP LIGHT INDICATIONS

Automatic sanding, together with reduction of locomotive power functions to correct wheel slip. After adhesion is regained, a timed application of sand continues while power is smoothly restored. Provided the auto sand switch is ON the system functions entirely automatically, and no action is required by the locomotive operator.

NOTE: Whenever possible, operation on grades should be at full throttle position. Throttle reduction or manual reduction in power is recommended only when slip conditions are such that repeated wheel slip causes severe lurching that may pull a train apart.

Depending upon the seriousness of the slipping condition, the wheel slip light may or may not flash on and off as the wheel slip control system functions to correct the slips. However, the IDAC wheel slip control system reacts so rapidly to correct minor slips that the wheel slip light seldom comes on to indicate severe slips. The wheel corrective action is often seen at the load current indicating meter as a steady reduction of load current below that which is normally expected at full throttle for a given speed. Do not misinterpret this power reduction as a fault. It is simply the wheel slip control system doing its job and maintaining power at a level within the adhesion conditions established by track and grade.

If the wheel slip light blinks on and off slowly and persistently during locomotive operation, a pair of wheels may be sliding or circuit difficulty may exist. Due to the seriousness of sliding wheels, under such indications the locomotive should be IMMEDIATELY STOPPED and an investigation made to determine the cause. The wheels may be sliding due to a locked brake, damaged traction motor bearings, or broken pinion or gear teeth. Repeated ground relay tripping, accompanied by unusual noises such as thumping or squealing, may also indicate serious traction motor trouble that should be investigated at once.

Do not allow any unit that must be isolated due to repeated wheel slip or ground relay action to remain in a locomotive consist UNLESS IT HAS BEEN ABSOLUTELY DETERMINED THAT ALL OF ITS WHEELS ROTATE FREELY.
INTRODUCTION

This section is devoted to operational problems that may be encountered on the road and the steps that can be taken to determine their cause and to make necessary corrections. No attempt is made to provide detailed explanations of the equipment functions concerned.

Troubles occurring on the road and the resulting delays can be minimized through proper locomotive inspection, maintenance and operation. When operating problems do occur, however, it is important that they be quickly eliminated. Towards that end, a good, thorough understanding of locomotive equipment function is helpful. This basic knowledge, together with the suggestions given in this section should provide the necessary means for achieving the “on time” performance desired.

GENERAL PROCEDURE

Safety devices automatically protect the equipment in case of faulty operation of almost any component. In general this protection is obtained by unloading or preventing the loading of the diesel engine, with a resulting loss of locomotive pulling power. In most instances, the diesel engine speed will be reduced to idle. Operating difficulties are usually indicated by the ringing of an alarm bell and the lighting of one or more signal lights. The alarm circuit is arranged so that the bells will ring in all units of a multiple unit consist, but the signal light will be on only in the unit experiencing the trouble. With this arrangement the unit in trouble can be quickly detected.

ALARM BELL RINGS – NO SIGNAL LIGHTS ON IN LEAD UNIT

A multiple unit consist may be operated from an isolated lead unit. (Isolation Switch in START).
TROUBLE SHOOTING

Cause — 1. If the bell rings continuously the fault is in a trailing unit and may be one of the following:

(a) Hot engine — Red. Hot Engine light will shine in defective unit. Engine speed and power will remain normal in all units. Refer Alarm Signal Lights in Trouble Shooting Section for correction.

(b) Ground Relay — Red. Ground Relay light will shine, engine speed will reduce to idle, and power is lost in the defective unit only. Refer "Alarm Signal Lights" in Trouble Shooting Section for correction.

(c) Excitation Limit Relay — Amber. Excitation Limit Light will shine, engine speed will reduce to idle and power is lost after 60 secs. (GF drops out). Refer "Alarm Signal Lights" in Trouble Shooting Section for correction.

(d) D14 Alternator Failure — Red. Alternator Failure Light will shine (no volt relay NVR dropped out) engine speed may be reduced to idle or engine may be stopped. Refer "Alarm Signal Lights" in Trouble Shooting Section for correction.

(e) Engine Shuts Down — Red Alternator Failure light will shine. (No volt relay NVR dropped out). Refer "Alarm Signal Lights" in Trouble Shooting Section for correction.

ALARM SIGNAL LIGHTS

Colored alarm signal lights are located on the engine control panel on the rear cab wall. Additional red signal lights are located on the locomotive controller.
TROUBLE SHOOTING

RED – HOT ENGINE

Cause – Excessive engine cooling water temperature.

Effect – Alarm bells ring in all units. Engine speed and power remain normal.

Correction – To silence the alarms and extinguish the light it will be necessary to reduce engine cooling water temperature.

1. Isolate unit and allow engine to run at idle.
2. Check water tank to see if there is sufficient water in system.
3. Check to see if cooling fans are running.
4. Shutters should be open. If closed, check position of shutoff valve in air supply line. Located on the LHS of longhood on bulkhead partition above the equipment rack.

BLUE – ALTERNATOR FAILURE

Cause – D14 alternator failure: thus, no AC auxiliary power is being generated, NVR drops out and excitation is removed from the main generator. May be due to loss of D14 alternator excitation or electrical difficulty in the system (true failure). May also be caused by the diesel engine stopping for any reason while on the line (false failure).

Effect – Alarm bells ring in all units. If the failure was due to electrical fault, the engine in the unit concerned will go to idle speed.

Correction – To silence alarms, isolate unit. Method of correction depends upon whether failure was due to electrical or mechanical fault.

A. Engine Stopped (not true D14 failure)

1. Engine overspeed device tripped. Check lever position, reset if necessary.
TROUBLE SHOOTING

2. Low water or crankcases (oil pan) pressure detector tripped. The engine protector light will also be on and governor low oil plunger tripped.

3. Engine starving for fuel. Observe for proper fuel flow through return sight glass by operating fuel pump. If fuel is not evident, check reasons given in this section under "Insufficient Fuel".

4. Throttle lever in STOP position.

5. Low oil pressure. Engine protector light will be on and governor low oil plunger tripped.

6. Hot Engine Oil Detector — Engine protector light will be on and governor low oil plunger tripped.

7. FPC (fuel pump contactor) de-energised (engine stops immediately).

B. D14 Failure (engine idling).

1. Blown 60-ampere alternator field fuse.

2. Blown 150-ampere auxiliary generator fuse.

3. Tripped 30-ampere auxiliary generator field circuit breaker.

AMBER — ENGINE PROTECTOR — LOW OIL/LOW WATER/CRANKCASE PRESSURE/HOT OIL DETECTOR.

Cause — Low oil pressure or high oil temperature in the engine or turbocharger lubricating systems. May be due to insufficient oil, excessively hot oil, diluted oil, or clogged strainers or incorrectly seated oil strainer gasket.

A low oil pressure indication is also given when the crankcase pressure/low water detecting device is tripped or hot oil detector has operated. This is because these devices dump oil from the low oil pressure detector in the engine governor.

Effect — The diesel engine in the unit concerned will be stopped and the red light on the engine control stand will be on. The pushbutton on the
TROUBLE SHOOTING

governor will be out with the red indicating band exposed. The blue ALTERNATOR FAILURE light will also come on as NVR drops out due to no D14 voltage. The alarm bell will ring if the isolation switch is in RUN.

Correction — The following steps should be taken to correct or determine cause of difficulty.

1. Isolate unit to stop alarm bells.

2. Reset governor trip button. Red engine protector light will go out.

3. Check engine lubricating oil level using dipstick. Oil should be approximately six inches above the FULL mark when engine is stopped.

4. Observe for external oil leakage from broken pipes.

5. Check the low water and crankcase (oil pan) pressure detecting device mounted on the engine. If the lower button protrudes, the failure is due to low water. If the upper button protrudes, the failure is due to excessive oil pan pressure.

NOTE: If governor low oil plunger trips to shut the engine down, but the crankcase and low water detector buttons remain set, check oil and water levels. If oil level is satisfactory and water level is marginal, the hot oil detector may have tripped. There is no indicator for such a trip except a very hot engine condition. Do not attempt to restart engine. Report engine shutdown circumstances to authorized maintenance personnel.

**Upper Button Protrudes**

**Cause** — Oil pan pressure exceeds a predetermined positive pressure setting. May be the result of gases entering the oil pan through cracked pistons, badly worn rings, broken rings, or due to a dirty oil separator.

**Effect** — Engine shut down.

**Correction** — Reset governor low oil trip plunger. Manually reset the device by holding the button in for 5 seconds. Proceed with the checks shown for
TROUBLE SHOOTING

low oil shutdown.
It is not recommended that the upper button (crankcase pressure) be reset more than once unless it is apparent that the latching mechanism is defective.

Lower Button Protrudes

Cause — Low water level, sudden loss of engine water, or low water pressure at engine start.
Effect — Engine shuts down. If water level is only slightly low, the engine may shut down only at high throttle positions.
Correction — Check for water leaks. Add water. Reset governor low oil trip plunger. Press detector reset button and hold for 5 seconds immediately after restarting engine.

6. Check that lubricating oil viscosity is not reduced due to dilution with fuel oil.

7. Check that oil viscosity is not reduced due to excessive heat. In such case the hot engine alarm may also be activated.

8. Restart engine after reset buttons have been pressed and corrective action taken. Observe oil pressure on gauge. It should be a minimum of 9 psi (62 Kp) with engine at idle.

CAUTION: In the event of continued low oil pressure, or low water, the governor trip button will again move to stop the engine. The engine should not be repeatedly started or forced to run when the governor keeps shutting down the engine. The engine should NEVER be manually operated by using the layshaft lever to take control away from the governor when the governor persists in stopping the engine.

RED – GROUND RELAY

Cause — Insulation failure, presence of water, or an electrical arc in high voltage circuits or phase
TROUBLE SHOOTING

unbalance to the A.C. Windings in the A.R. 10 Alternator.

Effect — The light comes on when the ground relay trips. Engine speed will be reduced to idle, power is lost, and the alarm bell rings.

Correction — Press the ground reset button on the control stand. The light will go out, the bell will stop, power will be smoothly restored and engine speed will return to that called for by throttle position on the lead unit. No action should be taken to cancel a small enunciator light on the Ground Detection Light Relay (GDL) in the electrical cabinet. This light should be reset by maintenance personnel only.

WARNING: When the alarm rings for the third time after using the ground reset button twice, the affected unit should be isolated.

AMBER — EXCITATION LIMIT

Cause — Tripped excitation limit delay relay due to excessive generator field current. May be caused by defective excitation circuit or a defective rate control panel. The excitation limit relay may also trip if the backward transition relay fails to operate properly or as a result of OVR (Over Voltage Relay) operation. The overvoltage relay provides protection from excessive voltage from the main generator. If main generator voltage rises above an acceptable level, the OVR relay picks up. Pickup of OVR provides a feed to the ELD relay and also operates to discharge the rate control capacitor. The immediate response contacts of ELD provides a feed to ELR and also operate to discharge the rate control capacitor.

If the overvoltage condition persists for 60
TROUBLE SHOOTING

seconds, the time delay contacts of ELD operate to drop out GF and also causes the alarm to sound, excitation limit light to come on, and provides holding circuit for ELD. Power can be restored by returning the throttle to IDLE, to drop out ELR and ELD, then advancing throttle to the desired position. If the alarm and excitation light comes on again after the unit is placed on the line and power is restored, isolate the unit.

Effect – The alarm bell rings, the engine on the unit affected will go to idle speed and the generator field contactor (GF) will drop out after 60 seconds.

Correction – Return throttle to idle position to stop the alarm and drop out the excitation limit relay. After a slight delay, reopen the throttle. If the excitation limit light and alarm occurs again, isolate the unit.

BLUE – TURBO LUBE PUMP

This is not an indication of a fault. It merely provides an indication that the auxiliary pump is delivering oil to the turbocharger bearings. When the light is on after load operation at throttle position No. 3 or higher, the main battery switch should remain closed for 35 minutes.

RED – WHEEL SLIP

Cause – Severe wheel slip causes the wheel slip light to come on. Minor and moderate slipping does not cause the light to come on.

Effect – Minor slips are corrected by instantaneous power reduction. Moderate slips bring about a greater reduction of power in addition to a timed application of sand. Severe slipping causes the wheel slip light to come on.

Correction – Corrective action is automatic. Power should be reduced only if severe lurching threatens to break the train.
TROUBLE SHOOTING

WARNING: A unit experiencing repeated and persistent wheel slip action should not be isolated and allowed to remain in the locomotive consist unless inspection reveals that all wheels are capable of rotating freely.

RED -- BRAKE WARNING

Cause -- Excessive dynamic braking current.

Effect -- No noticeable effect. Dynamic brake resistor grid damage is possible if corrective action is not taken.

Correction -- Excess braking current is usually quickly and automatically corrected by the dynamic brake regulator. In the event the warning light blinks excessively, the throttle should be moved to reduce braking strength. The light should never be allowed to blink on and off more than three seconds.

CORRECTION OF OPERATING DIFFICULTIES

INSUFFICIENT FUEL

Insufficient fuel will cause erratic engine operation. Lack of fuel will cause engine to shut down. It will also prevent an engine from being started.

Condition of the fuel system may be determined by observing the two sight glasses mounted on top of the filter assembly located at the governor end of the engine. The glass closest to the engine should be full whenever the fuel pump and engine are running. The other adjacent glass should always be empty.

FOR FUEL PUMP TO OPERATE

1. Main battery switch must be closed.
2. Control and local control circuit breakers must be ON.
3. Control and fuel pump switch must be ON.
4. Fuel pump 30-ampere circuit breaker must be ON.
5. FPC and FPR coils must be energized.
6. Auxiliary generator must be developing power.
TROUBLESHOOTING

NO FUEL WITH PUMP RUNNING
1. Lack of fuel in tank.
2. Slipping or broken coupling between motor and pump.
4. Clogged suction or discharge filters.

ENGINE CANNOT BE STARTED

Engine starting difficulties fall into two categories; namely, engine does not rotate in START position, or engine rotates but does not fire. The following items should be checked in either event.

Engine Does Not Rotate
1. Main battery switch must be closed.
2. Isolation switch must be in START position.
3. Vigilance selector switch must be in SINGLE or LEAD.
4. Starting 800-ampere fuse must be good and in place.
5. Control and local control circuit breakers must be closed.
6. Control and fuel pump switch must be in ON position.
7. GS and GSA contactors must pick up.
8. Both cranking motor pinions must mesh.
9. Engine must not contain hydraulically locked cylinder. Always report stalled cranking attempts to proper maintenance personnel.

Engine Rotates But Does Not Fire
1. Engine overspeed trip lever must be set.
2. Low oil pressure button in governor must be in.
3. Fuel system must be sufficiently primed, and layshaft lever must be positioned at about 1/3 rack.
4. Local control circuit breaker must be in ON position.
TROUBLE SHOOTING

5. Governor shutdown solenoid DV must be de-energized.

ENGINE STOPS SOON AFTER STARTING
1. Fuel pump circuit breaker must remain closed.
2. Control and local control circuit breakers must remain closed.
3. Control and fuel pump switch must remain ON.
4. Low water and crankcase (oil pan) pressure detector buttons must be set.
5. If the engine stops when the isolation switch is turned to RUN the throttle may be in STOP position.

ENGINE DOES NOT RESPOND TO THROTTLE
In instances where an engine is running normally at idle speed but does not speed up when throttle is advanced, the indication is that the governor speed control solenoids AV, BV and CV are not receiving power. Generally, this condition would be due to the ER relay being de-energized. The following items should be checked:
1. Ground and fault relays must be set.
2. NVR must be energized.
3. Isolation switch must be in RUN.
4. Vigilance selector switch must be in SINGLE or LEAD.
5. DPC (Dynamic Pneumatic Contactor) and PCR (Pneumatic Control Relay) must be picked up.
6. Engine run switch must be ON.
7. Control circuit breaker and control and fuel pump switch must be in ON position. In addition to lack of throttle response with these devices OFF, the engine will in a few minutes shut down from lack of fuel.
8. Backward transition relay not functioning properly.
9. Excitation limit and overvoltage relays not functioning properly.
TROUBLE SHOOTING

DYNAMIC PNEUMATIC CONTACTOR (DPC) NOT PICKED UP

The Dynamic Pneumatic Contactor (DPC) will drop out when brake pipe pressure falls below 45 psi (310 Kp). This may result from—

(a) An emergency brake application by the driver.
(b) A Vigilance Penalty Valve application.
(c) Conductor or Guard’s valve application.
(d) Train break in two.

Pneumatic Control Relay (PCR) is de-energized when DPC drops out. The speed and power of ALL engines in a multiple unit consist is reduced to IDLE. No alarm bells will ring. The PCR will reset automatically if the throttle is placed in IDLE and brake pipe pressure is restored to more than 56 psi, the pick up value of DPC.

In the event of a brake application from (a) (b) (c) or (d) above proceed as follows:

For (a) place automatic brake handle in RELEASE. Independent brake handle in FULL APPLICATION. Throttle in IDLE.

For (b) proceed as in (a) above and also lift the pin on the penalty application valve on the side of the RHS control stand.

For (c) and (d) return throttle to IDLE. It is recommended that after the train stops, the automatic brake valve be placed in emergency position and allow to remain there until the cause of the application has been corrected. Then proceed as for (a) above.

LOCOMOTIVE DOES NOT LOAD UP

In instances where the diesel engine is running and responds properly to throttle but the locomotive does not load up, the following points should be checked:

1. Reverse lever must be in either forward or reverse.
2. Selector lever must be in power - No. 1 position.
3. Generator field switch must be ON.
TROUBLE SHOOTING

4. Generator field circuit breaker must be ON.
5. Power contactors must pick up.
6. Generator field contactor must pick up and overriding solenoid must remain de-energized.
7. Brake warning light must not come on when selector lever is placed in brake position.

ENGINE GOES TO IDLE DURING OPERATION
See possible causes in preceding article entitled “Engine Does Not Respond To Throttle.”

NOTE: Control circuit breaker may be tripped. The trigger will be in mid position. To reset, move the trigger all the way to OFF then move to ON!

ENGINE STOPS DURING OPERATION
In instances where a diesel engine stops during normal operation, the following items may be responsible.

1. Throttle may be in STOP position.
2. Engine overspeed trip may have occurred.
3. Low oil button on governor may be out.
4. Crankcase (oil pan) pressure / low water detector tripped.
5. Hot Engine Oil Detector causing governor low oil button to trip.
6. Insufficient or lack of fuel. See preceding fuel system difficulties.
7. Auxiliary generator fuse or circuit breaker may have opened.
8. FPC de-energized. Local control circuit breaker tripped.
9. Control circuit breaker may be tripped.

BATTERY CHARGING METER SHOWS DISCHARGE
With the diesel engine running, the auxiliary generator should provide all low voltage current needs. The battery charging ammeter should read either zero or charge. If it continually reads discharge, the following should be checked.
TROUBLE SHOOTING

1. Auxiliary generator fuse must be good and in place.

NOTE: A strong discharge reading at engine stop, followed by a burned out auxiliary generator fuse, indicates a shorted battery charging rectifier.

2. Auxiliary generator field circuit breaker (30-ampere) must be ON.

3. Voltage regulator must be operative and properly adjusted.

UNUSUAL OPERATING PROBLEMS

In the majority of instances, the various safety devices will function in the event of trouble to safeguard the equipment by unloading the engine, or causing it to go to idle or stop. There are instances however, when such action is not automatically taken and it may be advisable to take manual action. Since these occasions are unusual, each should be handled individually, using good judgment. The following suggestions may be helpful.

Mechanical Problems

1. Smoke Coming Out of Exhaust — Operation may continue.

2. Oil or Fire Coming Out of Exhaust — Stop engine.

3. Smoke in Engine room Coming from Engine — Stop engine, DO NOT REMOVE ANY INSPECTION COVERS.

4. Governor Low Oil Button Trips Repeatedly — This may be due to low oil, positive crankcase pressure, hot oil or low water pressure. If the shutdown is due to low or hot oil or positive crankcase pressure refer to “Alarm Signal Lights” (Engine Protector) in Trouble Shooting section. If shutdown is due to low water, it may be possible to operate the engine at reduced throttle if the low water reset button on the crankcase pressure/low water detector stays in when pressed after engine is restarted.

5. Unusual Noises — Investigate source. Stop engine or discontinue operation to prevent damage if noise is pronounced.

6. Engine Cylinder Test Valve Leaking — Do not allow engine to operate with leaking or blowing test valves.
TROUBLE SHOOTING

7. Safety Valves Popping On Air Compressor Intercooler or Main Reservoir — Continue operation.

8. Engine Overspeed Trip Stops Engine Repeatedly — Operate in reduced throttle notches where possible.

Electrical Problems

1. Ground Relay Tripped Light Comes on Repeatedly — Isolate unit after three indication. Stop locomotive and check to see that all wheels can rotate freely.

2. Continued Wheel Slip Indication — Isolate unit; Stop locomotive and check to see that all wheels can rotate freely.

3. Loss of power is evident, but no alarm indication is given and the reason for the difficulty can not be determined. Operation may continue, but the condition should be reported to proper maintenance authority.

CAUTION: Excitation of the main generator for test purposes without load or lightly loaded should be restricted to an absolute minimum.
GENERAL ARRANGEMENT

No.1 ELECTRICAL CABINET. DRIVERS CAB SIDE
NO.1 ELECTRICAL CABINET -- DRIVERS CAB SIDE

Top Left Hand Side

P.C.P.  Performance Control Panel
D.B.R.  Dynamic Brake Regulator
B.W.A.  Brake Warning Aux. Relay
B.W.R.  Brake Warning Relay
L.O.R.  Lock-out Relay
I.R.R.  Increase Resist Relay
D.R.R.  Decrease Resist Relay
S.B.P.  Sensor Bypass Panel
R.C.P.  Rate Control Panel
G.F.R.  Generator Field Relay
B.R.  Brake Relay
T.L.P.C.  Turbo Lube Pump Contactor
B.P.R.  Brake Program Relay
T.D.P.  Program Time Delay Relay
M.F.P.  Motor Field Protection
P.R.  Parallel Relay
G.R.  Ground Relay
O.V.R.  Over Voltage Relay
N.V.R.  No Volt Relay
T.L.T.D.  Turbo Lube Time Delay Relay
G.D.L.  Ground Detect. Latching Relay
F.T.X.  Forward Trans. Aux. Relay
F.O.R.  Forward Relay
R.E.R.  Reverser Relay
P.R.A.  Parallel Aux. Relay
P.C.R.  Pneumatic Control Relay
F.P.R.  Fuel Pump Relay
E.R.  Engine Relay
T.R.P.  Throttle Response Panel
F.P.C.  Fuel Pump Contactor
V.R.  Voltage Regulator
R.T.L.  Trainline Reduction Relay
P.R.R.  Power Control Relay
I.S.A.  Isolation Sw. Aux. Relay
R.A.  Reverser Relay

Top Right Hand Side

W.L.  Wheel Slip Light Relay
T.D.S.  Sanding Time Delay Relay
W.S.14)  Wheel Slip Relays
W.S.36)  Wheel Slip Control Relay
W.S.C.  Wheel Slip Control Relay
B.3 Brake Contactor
G.F. Generator Field Contactor
G.F.A. Generator Field Aux. Contactor
M.12 Motoring Contactor
P.1 Parallel Contactor
S.14 Series Contactor
P.4 Parallel Contactor
B.P.S. Brake Program Switch
R.V.F.3 Reversing Contactor — For
B.23 Braking Contactor
R.V.F.2 Reversing Contactor — For
G.P.T. Transformer
E.L.R. Excitation Limit Relay
R.V.F.1 Reversing Contactor — For
P.3 Parallel Contactor
S.36 Series Contactor
P.6 Parallel Contactor
G.F.D. Generator Field Decay Contactor
G.5 Starting Contactor
G.S.A. Start Aux. Contactor
L.I.A.S. Load Indicator Amp. Shunt
No.1 ELECTRICAL CABINET, ENGINE ROOM SIDE
NO.1 ELECTRICAL CABINET – ENGINE ROOM SIDE

S.C.R.  Silicon Control Rectifier
C.R.—B.C.  Battery Charging Rectifier
R.—B.C.  Battery Charging Resistor
B.C.T.7)  Transducers (Brake Current)
B.C.T.6)  
W.S.T.24)  Wheel Slip Transducers
W.S.T.16)  
W.S.T.35)  
F.T.R.  Forward Transition Relay
B.T.R.  Backward Transition Relay

NO.2 ELECTRICAL CABINET (LONG END NOSE)

P.2  Parallel Contactor
S.25  Series Contactor
P.5  Parallel Contactor
B.  Braking Contactor
O.C.L.  Open Circuit Latch Relay
E.T.T.  Electro – Thermo Timer
W.S.25  Wheel Slip Relay
O.C.P.  Open Circuit Protector
B.6  Braking Contactor
R.V.R.4  Reversing Contactor — Rev.
M.45  Motoring Contactor
R.V.R.5  Reversing Contactor — Rev.
B.56  Braking Contactor
R.V.R.6  Reversing Contactor — Rev.