

Louisville & Nashville R. R. Co.

**REGULATIONS GOVERNING USE OF
UNION CONTINUOUS AUTOMATIC
TRAIN CONTROL**

K. & A. DIVISIONS

November 1, 1942

1737-11-42

**UNION CONTINUOUS, ONE-SPEED, TWO
INDICATIONS AUTOMATIC TRAIN CONTROL
KNOXVILLE AND ATLANTA DIVISION**

Louisville & Nashville R. R. Co.

Rules and Instructions Governing the Inspection, Maintenance, and Operation of Locomotives Equipped with Union Continuous One- Speed, Two Indications Automatic Train Control

As the safety and normal operation of trains largely depend on the proper observance of the Cab Indicator Signals, and compliance with the indications given, it is of the utmost importance that employes having anything to do with the operation of trains be perfectly familiar with the meaning of the signal indications and functioning of the train control device. It is also of the utmost importance that employes having anything to do with the maintenance of the apparatus be perfectly familiar with the method of testing, inspecting, maintaining, and operation of the Union Continuous One-Speed, Two Indications Automatic Train Control. All concerned should carefully study these rules and explanations as to the proper method of testing, inspecting, maintaining, and operating the device.

The purpose of Automatic Train Control is to exact obedience to cab signal indications. That is to say, if the engineman should in any way become incapacitated or fail to observe the rules or special instructions governing the use of Automatic Train Control, the device will function and bring the train to a stop short of a stop signal or an obstruction. The device will also enforce a speed restriction of 20 miles per hour while operating through an occupied or obstructed block, or siding, or yard, by automatically applying the brakes should the train exceed 20 miles per hour, and requiring an act of the engineman to release the brakes after the train speed has decelerated below the restricted speed.

GENERAL DESCRIPTION

The Union Continuous One-Speed, Two Indications Train Control as installed on the Louisville & Nashville R. R. Co., consists primarily of:

1. Track or Wayside Equipment which operates in connection with the Automatic Block D. C. track circuits, to establish communication to the Locomotive Electric Equipment as to the condition of the track ahead. The Wayside Equipment consists of a source of Alternating Electric Current connected or supplied to the rails through transformers, relays, etc., and is connected or spaced off in sections braking distance or maximum safe braking distance apart. As long as the track condition ahead will permit maximum allowable speed running, the current will flow down one rail, across the engine truck or pony truck wheels and back the other rail. If the track ahead is in such condition that the train should be at a speed under control preparatory to stopping at a stop signal, or an obstruction, a relay will disconnect the current from the rails and no current will flow in the rails.
2. Locomotive Electric Equipment which operates in conjunction with the signaling current in the rails to establish a visual signal indication in the cab and operate an air valve, by which the speed of the train shall be governed.
3. Locomotive Pneumatic Equipment which controls the Automatic Application of the brakes whenever conditions may require.
4. The Electric Equipment consists of:
 - (a) The receiver coils mounted on the pilot, about 8 inches above the rails. The purpose of the receiver coils is to pick up the signaling current in the rails by induction, and the circuit of the current so induced, is completed through the amplifier set for the purpose of operating the train control relay.
 - (b) The electric equipment box located on top of the boiler, which contains the amplifier, train control relay, cut-out relay, and other electrical apparatus; on Diesel Locomotives in the hood.
 - (c) The two-light cab indicator located in the cab in the engineman's line of vision. The purpose of the cab indi-

cator is to give the engineman a continuous visual signal of the condition of the track ahead. When the indicator is showing GREEN light maximum allowable speed is permitted. When the indicator is showing a RED light the track ahead is occupied or obstructed and the speed must be controlled in accordance with rules or special instructions.

(d) The high speed (or electric) cut-out switch conveniently located in the cab for the engineman to operate. The purpose of the cut-out switch is to annul the effect of train control on leaving equipped territory and to avoid the changing of the cab indicator light from RED to GREEN to RED while entering and leaving sidings and operating through yards. The cut-out switch is also the acknowledging switch on locomotives equipped with electric speed governors. The switch must be operated to acknowledging (up) position to forestall a train control application on entering a danger zone, or siding, or yard, and to release the device after a train control application has been imposed.

(e) The electric-pneumatic (or magnet) valve located on the governor group. The purpose of the magnet valve is to determine the position of the valve of the pneumatic equipment in high speed or low speed positions as the conditions may require.

(f) The headlight generator on steam locomotives furnishes electric current to the electric equipment. On Diesel locomotives, a motor-generator located in the hood is used in place of the headlight generator. Necessary conduit and wire connecting the several parts.

(g) The electric speed governor attached to front engine truck or pony truck axle of several locomotives so equipped. The purpose of the electric speed governor is to enforce a speed restriction of 20 miles per hour while operating through a danger zone, or siding, or yard.

(h) All Diesel locomotives are equipped with electric speed governor, which imposes maximum high speed in train control and non-train control territory.

(i) The selector switch on Diesel locomotives, located in the hood. The purpose of the selector switch, is to determine the operation of the device over train control, train stop, and non-train control territory.

5. The Pneumatic Equipment consists of:

(a) The application group, which under certain conditions gives an automatic application of brakes.

(b) The governor group and governor drive located on the front end of the locomotive and attached to the front engine truck or pony truck axle. The purpose of the governor group and drive is to govern the speed of a train while operating through a danger zone, or siding, or yard, and also to regulate the delay time.

(c) The acknowledging valve conveniently located in the cab for the engineman to operate (except locomotives equipped with electric speed governor). The purpose of the acknowledging valve is to permit the engineman to forestall an automatic brake application on entering the danger zone, or siding, or yard.

(d) The engineers brake valve, the manual operation of which is the same as the Standard H-6 Brake Valve on steam locomotives, and MS-40 Brake Valve on Diesel locomotives.

(e) Five (5) reservoirs known as the Blow-down, Stop, Quick Release, Suppression Limiting, and Acknowledging Reservoirs. The purpose of the reservoirs is to give air volume to the several pipes to which they are connected.

(f) The brake pipe vent valve and emergency brake cylinder pressure maintaining valve located near the distributing valve of the engine brake equipment. The purpose of the vent valve and maintaining valve is to make possible a manual emergency application during a train control application of brakes if conditions warrant. The valves will also permit the engineman on the second locomotive in double-heading service to make a manual emergency application without operating the double-heading cut-out cock.

OPERATING INSTRUCTIONS AND EXPLANATIONS FOR HOSTLERS AND ENGINEMEN

6. The instructions contained herein do not conflict with special rules governing the use of Air Brake and Whistle Signal, nor the rules of the Transportation Department, except as stated in second paragraph of Rule No. 17, wherein Rule 292 and 509-A of Transportation Rules will govern when a train that is operating with the device cut-out is stopped by a STOP and PROCEED signal.

INSTRUCTIONS TO HOSTLERS

7. Special test circuits are provided at Atlanta, Etowah, West Knoxville, and Corbin for the hostlers to test the apparatus.
8. It is the hostler's duty to see that the train control is properly cut in for service and operative before the locomotive leaves the ready track.

Satisfactory performance of the equipment during this test is the hostler's assurance that the locomotive is in condition for service over equipped territory.

9. He should observe:
 - (a) That the air compressors are working.
 - (b) Brake valves in running position, and the air gauges showing the proper pressure.
 - (c) That the pneumatic cut-out valve lever on the application group is sealed in the cut-in position.
 - (d) Acknowledging valve in running position.
 - (e) The main switch is in closed (on) position. The headlight generator running on steam locomotives. The motor-generator running on Diesel locomotives. The selector switch in train control position on Diesel locomotives.
 - (f) High speed cut-out switch under cab window in running (down) position. Diesel locomotives not equipped with high speed (electric) cut-out, the acknowledging switch should be in normal (N) position.

10. A test of the equipment must be made over the test track in the following manner: The locomotive should be stopped with the pilot over the first circuit. A GREEN cab light will indicate that the electrical equipment is cut in and operative. The blow-down pressure, indicated by the black hand on the train control duplex air gauge should charge to 70 lbs. pressure. Locomotives equipped with electric speed governor-single hand gauge should charge to 50 pounds. Run the locomotive off the first circuit. When RED light appears, stop with independent brake valve. The change in cab light must not be acknowledged. An automatic application of the brakes should follow within 45 seconds after the cab light changes from GREEN to RED. This will indicate that the equipment is operative. The automatic brake valve should be placed in lap position

and the brakes released after the main reservoir pressure is restored to the brake valve. The main reservoir pressure should be restored within 45 seconds after the brake valve is placed in lap position, and the automatic application starts. Locomotives equipped with electric speed governor, operate the high speed cut-out switch to cut-out or up position in addition to lapping the brake valve after the automatic application starts. On Diesel Locomotives the release time should be within 70 seconds.

11. Run the locomotive over the second circuit. A GREEN cab light should then be displayed. Operate the high-speed cut-out switch to cut-out or (up) position, and leave it in that position until the cab light goes out, and within 4 seconds return this switch to running (down) position. If the cab light fails to display either RED or GREEN, the high speed cut-out has taken place. Note that the blow-down pressure remains at 70 pounds. Locomotives equipped with electric speed governor blow-down pressure 50 pounds.
12. One or two minutes after the cut-out switch is returned to running position, operate the switch to cut-out position. A RED cab light should be displayed. Acknowledge the RED light by moving acknowledging valve handle to acknowledging (A) position; then an automatic application should not follow. Locomotives equipped with electric speed governor the operation of the cut-out switch from running to cut-out position should prevent the application.
13. If the above tests fail, notify roundhouse foreman; and if correct, locomotive is ready.
14. The locomotive should be delivered to the engineman with the acknowledging valve in acknowledging (A) position, and the high speed cut-out switch in cut-out (up) position and RED light displayed in cab. The acknowledging switch on locomotives not equipped with high speed (electric) cut-out, should be in normal (N) position.

INSTRUCTIONS TO ENGINEMEN

15. It is the duty of the engineman to see that the train control pneumatic cut-out valve lever is properly cut in and sealed, and that the high speed cut-out switch is in the cut-out (up) position and acknowledging valve is in acknowledging (A) position and with RED light displayed in cab. The equipment should be left in this position until

the locomotive is entering train control territory when cut-out switch must be placed in running (down) position. The acknowledging switch on locomotives not equipped with high speed (electric) cut-out should be in normal (N) position.

16. **Movements Operated Cut-Out.** When the automatic train control equipment fails to operate as intended, engineman must not cut it out of service, except in emergency (inability to release brakes) without first obtaining authority to do so from the train dispatcher. If, however, the failure occurs at a point where Communication facilities are not available, the train dispatcher must be notified at the first point at which communication is available. When the train dispatcher authorizes the cut-out, or is advised of the failure of the device, he will be required to advise all opposing trains and closely preceding and following trains by (19) order that the train control is cut out on any train that is being operated without the protection of these devices.

One-half the maximum speed must not be exceeded while the apparatus is cut out, unless the train is protected by absolute block. To obtain absolute block protection under this rule, a train operating with train control cut out will not use block signal rule 291 and 509-B, but will consider a STOP and PROCEED signal as a STOP signal coming under Rule 292 and 509-A, of Operating Rules of the Transportation Department, and not pass it while indicating STOP and PROCEED except under flag protection.

If telephone booth is available advise the dispatcher before flagging.

If for any reason the train control is cut out, cut it back in service immediately after cause is passed or removed. Advise the dispatcher as promptly as possible by wire that the train control is back in service, stating mile where cut in.

17. **Conditions Governing Authority to Cut-Out:**

(a) Three or more automatic applications while carrying a continuous GREEN cab light. This only to avoid serious delay.

(b) Brakes cannot be released after an automatic application.

(c) Train control pipe breaking and causing automatic application. In addition to reversing the cut-out valve lever, if repairs cannot be made, plug the pipe where air is escaping.

(d) Failure to carry GREEN cab light through three or more blocks while block signals are in CLEAR position (except from north end of Tennessee River bridge to north end of West Knoxville yard, including main line to Knoxville Passenger Station, where cab light will show RED).

(e) Failure to effect high speed cut-out on leaving the main line at Jena, Mentor, Trevilion, Holton, Lot, Savoy, and Englewood. The equipment may be cut out while on the branch line, but when locomotives that have been running on branch lines with train control cut-out are returned to main line, enginemen must see that the train control is properly cut in before main line movement is made.

18. **Side-Track Movements.** Before entering side-track the cut-out switch must be operated to cut-out (up) position five-rail lengths before reaching switch and left in this position until the locomotive is five-rail lengths out of the siding. The RED cab light must be acknowledged when received. The acknowledging valve must be left in acknowledging (A) position until GREEN light is restored on the main line.

19. **Back-Up and Switching Movements.** Switching or back-up movements, with or without cars, must be made with cut-out switch in cut-out (up) position and acknowledging valve in acknowledging (A) position.

Back-up movements, either scheduled or regularly made in train control territory, must be made with locomotive equipped with back-up train control. When it is necessary to use a locomotive in Chaska Helper Service that is not equipped with back-up train control, the locomotive will be headed north and will be cut in the train directly behind the road engine.

20. **Doubleheading.** When two or more locomotives are coupled together, or when there is a car or cars between the locomotives, the engineman handling the head locomotive in the direction in which the locomotive may be moving must have control of the brakes, and all other locomotive brake valves must be cut out.

21. **High Speed Cut-Out.** Cut-out circuits at Englewood, Mentor, Jena, Trevilion, Holton, Lot, and Savoy are designated by sign marked "T. C. Cut-out," representing point where equipment can be cut out electrically. This can be done in the following manner:

(a) Upon entering the above branches, the high speed cut-out switch and acknowledging valve should be operated the same as when entering side track.

(b) When passing over the cut-out circuit, cab light should first change from RED to GREEN and then to dark (no light). The high speed cut-out switch should be operated to cut-in (down) position at once, and acknowledging valve moved to running (C) position and left in that position until these circuits are again reached, moving from branch toward main line, at which place the GREEN light should appear.

(c) When GREEN light appears, the high speed cut-out switch should be moved to cut-out (up) position and when RED light appears, same should be acknowledged.

22. Dossett-Harriman Branch:

The following will govern the operation of train control on locomotives moving over the Cow Creek Branch:

(a) Upon entering the Cow Creek Branch at Dossett, Tenn., the train control device on the locomotive may be cut out without obtaining authority from the train dispatcher.

(b) Upon returning to Dossett from the Cow Creek Branch, the device must be cut back in service and test made by the engineman before entering train control territory (main line).

The test must be made as follows:

Stop the locomotive over the test circuit on Cow Creek Branch main track at Dossett: With the high speed cut-out switch in running (down) position the GREEN cab signal should be displayed. Allow the blow-down pressure (No. 15) to charge to 70 pounds.

Application Test. Move the high speed cut-out switch to cut-out (up) position. The cab signal should change from GREEN to RED, and train control application should occur within 50 seconds' time. Place the automatic brake valve in lap position and the train control should release within 45 seconds.

Return the high speed cut-out switch to running (down) position and allow the blow-down pressure to charge to 70 pounds.

Acknowledging Test: Operate the high speed cut-out switch to cut-out (up) position and acknowledge when cab signal changes from GREEN to RED. The train control should not make an application.

If the above tests fail, the device may be cut out by obtaining authority in accordance with time table instructions, or Rule No. 17.

(c) A form has been provided, in the train order office at Dossett, on which the engineman, before returning to the main line at that point, will record the fact that he has complied with the foregoing instructions.

23. **Entering West Knoxville Yard.** When entering West Knoxville Yard, cab light will change from GREEN to RED, which should be acknowledged, and high speed cut-out switch operated to cut-out (up) position and left in this position until returning to train control territory.

24. To prevent or forestall automatic application of the brakes, the engineman must acknowledge the change of the cab light from GREEN to RED by moving the acknowledging valve handle from running position to acknowledging position. Locomotives equipped with electric speed governor the cut-out acknowledging switch must be moved from running to cut-out (up) position. If the speed of the train is above 20 miles per hour when the cab light changes, a manual service application of the brakes must be made in addition to acknowledging. As long as service brake pipe exhaust is blowing, or when a reduction of 21 to 30 pounds is made in the brake pipe or train line, an automatic application is prevented. As soon as the speed of the train gets below 20 miles per hour the brakes may be released, in accordance with air brake instructions, and the train can proceed at the restricted speed. In preventing automatic application by manual reductions, the service exhaust must not be permitted to stop blowing for more than two seconds between reductions.

Engineman shall not forestall an automatic application of the brakes until a restrictive signal has been observed and is being obeyed.

If the automatic application is not prevented, the train control will apply the brakes and stop the train. After the train control applies the brakes, the engineman may release the brakes by placing the brake valve in lap position, leaving it in that position for at least 45 seconds after the speed of the train gets below 20 miles per hour, or until the main reservoir pressure is restored to the brake valve. Locomotives equipped with electric speed governor, the cut-out acknowledging switch must be left in cut-out (up) position until after the brakes are released, in addition to lapping the brake valve. On Diesel locomotives, acknowledge after the application pipe pressure builds up above 80 pounds.

As soon as the main reservoir pressure is restored to the brake valve, the brakes can be released and the train may proceed at the restricted speed.

If a speed of 20 miles per hour is exceeded while running with a RED cab light, the train control will apply the brakes. This application can be prevented by the engineman holding the train to the restricted speed.

25. **Reporting Failures.** Failures and delays must be reported on Form 1802, revised July, 1927. If necessary to cut out the device notify the chief dispatcher, who will notify signal supervisor, train control supervisor, master mechanic by wire message. Form 1802 blanks and message forms are provided in locomotive cabs. In addition to this, a full report should be made on work report, Form 1458, on arrival at terminal.

INSTRUCTIONS AND EXPLANATION AS TO METHOD OF TESTING, INSPECTING, AND MAINTAINING FOR MAINTENANCE MEN

26. The maintenance men will be responsible for any failure or irregularities of the equipment that may be found by the hostler on making the departure test.
27. Whenever practical, confer with the engineman on the arrival of the locomotive, securing any information as to the performance of the equipment and information that may assist in determining cause of a failure.
28. The after trip test and inspection must be made as soon after the arrival of the locomotive as practical. The test may be made before or while the firebox is being cleaned.
29. The After-Trip Inspection Report form must be filled out on which should be recorded the condition of the equipment as found on the arrival and before any repairs or adjustments are made. Under **Remarks** on the form must be shown all irregularities as found by the test and repairs and adjustments made to correct the irregularities. Defects, irregularities, and repairs made should also be shown on Form 1458.
30. A general inspection of the entire equipment must be made, noting the condition of the electric equipment and

pneumatic equipment. Extreme care should be taken to note that all wiring, conduit, air pipes, castings, brackets, clamps, etc., are securely fastened to their supports and that no excess vibration is possible in any portion.

31. Inspect the pneumatic cut-out lever. If the lever is found in the cut-out position, or the seal is broken, the fact should be recorded on the inspection report form under **Remarks**, giving reasons for seal being broken, if ascertained. On Diesel locomotives examine selector switch lever, if found in improper position or seal broken, the fact should be recorded on inspection report under **Remarks**.

32. The test should be made as follows:

(a) **Normal Pick Up.** With the test track circuit closed, determine lowest current value at instant of train control relay pick up. Note and record the current value which should be between .20 and .30 ampere.

(b) **Cut-Out Pick Up.** With the track circuit closed and the high speed cut-out switch in the cut-out position, determine the lowest current value at instant of train control relay pick up. Note and record the current value which should be between 1.00 and 1.50 amperes.

(c) **Generator Voltage.** Note and record the turbo-generator voltage with cab lights (only) on and with full load on. The voltage should be between 31 and 34 volts with 150 and 200 pounds steam pressure. On Diesel locomotives the motor-generator should be between 31 and 34 volts.

(d) **Megohm Ground.** Test the insulation of the headlight and cab light wiring for grounds. Note and record the resistance to the ground which should not be less than one (1) megohm.

(e) **Pressures.** Note and record the steam pressure, main reservoir pressure, brakepipe pressure, constant feed pressure, pressure blow-down reservoir at instant automatic application is imposed. The constant feed pressure should be adjusted to 70 pounds if necessary before making pneumatic equipment test. Locomotives equipped with electric speed governors, pressure should be 50 pounds.

(f) **Acknowledging Feature.** With the test track circuit set with .3 ampere current, note the integrity of the acknowledging feature. This is done by acknowledging and 10 seconds after, obtain a change in cab signal by operating the cut-out switch. Locomotives equipped with elec-

tric speed governors, the test track current should be removed (open circuit) and when cab signal changes from GREEN to RED, operate acknowledging switch to acknowledging position and return to normal position. Acknowledging should prevent the automatic application.

(g) **Delay Time.** Note and record the delay time which is taken from the instant of the change in cab signal from GREEN to RED to the starting of the automatic application. The delay time should be between 34 and 44 seconds. Locomotives with electric speed governors, the delay time should be between 6 and 8 seconds.

(h) **Brake Pipe Reduction.** Note the brake pipe reduction made, this should be between 26 and 30 pounds with 80 pounds standard brake pipe pressure and between 30 and 32 pounds with 100 pounds standard brake pipe pressure. Note the lag in the falling of the brake pipe pressure when a reduction of 7 or 8 pounds has been made on locomotives equipped with split reduction feature.

(i) **Long Release Time.** Note and record the long release time which is taken from the instant of the starting of the automatic application to the instant the main reservoir pressure is restored to the brake valve. The time should be between 35 and 45 seconds. On Diesel locomotives, the long release time should be between 58 and 70 seconds.

(j) **Partial Suppression.** Note that a partial service reduction does not suppress the automatic application. This test is made by changing the cab signal from GREEN to RED and when the blow-down pressure falls to about 45 pounds make a manual service reduction of about 15 pounds. At the expiration of the delay time and with the brake valve in lap position, an automatic application should be imposed.

(k) **Permanent Suppression.** Note that full service reduction will suppress the automatic application. This test is made by changing the cab signal from GREEN to RED and when the blow-down pressure falls to about 45 pounds, make a manual service reduction of 20 to 21 pounds. Note that while making the reduction the application pipe pressure will fall. When the brake valve is in lap position, an automatic application should not be imposed.

(l) **Short Release Time.** Note and record the short release time. This should be taken with an automatic application imposed. With the brake valve in running position, change the cab signal from RED to GREEN and lap the

brake valve. Note the time from the instant the brake valve is placed in lap position to the instant the main reservoir pressure is restored to the brake valve. The short release time should not be more than 6 seconds.

(m) **Brake Cylinder Pressure Maintaining Valve.** With an automatic application imposed, operate the engineman's brake valve to emergency position. The brake cylinder should charge to emergency pressure. Operate the independent brake valve to release position and engine brakes should release. Restore the independent brake valve to running position and the brake cylinder should charge to emergency pressure.

(n) **High Speed Cut-Out.** With the test track current set to the cut-out valve, operate the cut-out switch to cut-out position, within four (4) seconds after the cut-out switch is operated, open the track circuit and return the cut-out switch to running position. Note that the blow-down pressure remains at 70 pounds, and that the RED signal is not received. Operate the cut-out switch to cut-out position and note that the RED signal is restored within 3 to 4 seconds.

33. All repairs and adjustments should be made while the locomotive is in the roundhouse. Defects or irregularities must be reported on the work report, Form 1458, and must be signed by the maintainer making repairs or adjustments before the locomotive is taken to the departure track.
34. The main reservoir and all dirt collectors must be drained before the departure of the locomotive. If excess condensation is noted, the fact should be reported under Remarks of the inspection report.
35. No locomotive equipped with train control apparatus should be permitted to leave the roundhouse unless such apparatus is in proper operating condition and with the pneumatic cut-out lever sealed in the cut-in position.
36. Quarterly test and inspection of the electric equipment must be made and the monthly report filled out and mailed to the Superintendent of Machinery not later than the fifth day of the following month. The test to be made in accordance with special instructions.
37. Quarterly inspection and test of the pneumatic equipment must be made in accordance with special instructions and record kept on form provided.

38. Locomotives overdue for quarterly inspection and test, or six-month cleaning of pneumatic equipment, or 2-year inspection and test of electric relays, amplifier, and receivers must not be permitted to operate over train control territory with the device in service, but may be used as second (2nd) locomotive in doubleheading.
39. The entire pneumatic equipment must be cleaned and tested every six months or sixth monthly inspection. Necessary record of cleaning must be kept by the division train control supervisor.
40. The electric equipment relays, amplifiers, and receivers must be removed from service every two (2) years, thoroughly cleaned, repaired, tested and adjusted to within limits of designed operating characteristics. Necessary record must be kept by the division train control supervisor.
41. The test loops must be properly maintained by the shop or roundhouse force. Departure test loops must be inspected and tested monthly and record kept in transformer box.
42. Signal or track circuit maintainers report to, and receive instructions from the signal supervisor. They are responsible for the inspection, adjustment, and proper maintenance of the train control track equipment.

FAILURE AND COMMON CAUSES FOR FAILURES

Automatic application on exceeding 10 or 20 miles per hour with GREEN cab signal:

- (a) Protection Interlock Valve not shifting.
- (b) Protection Governor not functioning properly.
- (c) Magnet Valve sticking in low speed position.
- (d) Pipe No. 15 broken or leaking.
- (e) Protection Governor Application Valve not seating.
- (f) Application Timing Valve or Relay Slide Valve sticking in low speed position.
- (g) Open circuit in Magnet Valve electric circuit.

Brakes cannot be released after automatic application:

- (a) Pilot Release Valve not seating.

- (b) Leaking or broken Pipe Nos. 4, 5, 14, 18, 33.
- (c) Application Pilot Valve sticking in application position.
- (d) Stop Reservoir drain cock leaking or open.
- (e) Leaking Gaskets.

Automatic application while carrying continuous GREEN cab light:

- (a) Train Control Feed Valve dirty and overcharging pneumatic equipment.
- (b) Train Control Safety Valve sticking in closed position allowing Pneumatic Equipment to become overcharged.
- (c) Excess vibration of pipes causing leaks.

Failure to carry GREEN cab signal while block signals are clear:

- (a) Failure of locomotive electric equipment.
- (b) Failure of wayside or track equipment.
- (c) Cut-out Switch in cut-out position.
- (d) Cab Signal Light burned out.

Cab signal lights flickering:

- (a) Low efficiency of Amplifier.
- (b) Low current value of track circuit.
- (c) Combination of (a) and (b).
- (d) Receiver Coils loose on core.
- (e) Low turbo-generator voltage, or low steam pressure.
- (f) Loose connection in electric equipment wiring.

Failure to effect high speed cut-out:

- (a) Open circuit in cut-out electric circuit.
- (b) Choke in air supply pipe restricted.
- (c) Low current value or open track cut-out circuit.
- (d) Improper operation of cut-out switch.

Failure to obtain train control relay pick-up:

- (a) Pilotron Tube Filament or Ballast Lamp burned out.
- (b) Open in Receiver Coils circuit.
- (c) Open in Amplifier circuit.
- (d) Open in Train Control Relay circuit.
- (e) Heavy grounds in locomotive wiring.
- (f) Open circuit from turbo-generator.

Normal pick-up—track current value too high:

- (a) Low emission of Pilotron Tube.
- (b) Defective Grid Leak.
- (c) Loose connections at terminals.
- (d) Receiver Coils loose on core.
- (e) Grounds in electric equipment wiring.
- (f) Low voltage of turbo-generator.
- (g) Poor commutation of turbo-generator and dynamotor.

Cut-out pick-up—track current value too high:

- (a) Open in cut-out circuit.
- (b) Loose connection at terminals of cut-out circuit.

Cut-out pick-up—track current value too low:

- (a) Short in cut-out circuit.
- (b) Cut-out Switch inoperative.

Failure of acknowledging feature:

- (a) Leaking Pipe Nos. 7 and 20.
- (b) Acknowledging Pilot Valve sticking or Piston failing to open Pilot Valve.
- (c) Leaking Acknowledging Valve and Acknowledging Pilot Valve Gaskets.

Delay time—too short:

- (a) Leaking Pipe No. 15.
- (b) Seal of Blow-down Timing Valve leaking.
- (c) Ring leakage of Blow-down Timing Valve.
- (d) Tension of Application Timing Valve Spring too great.

Delay time—too long:

- (a) Blow-down Timing Choke restricted.
- (b) Lower check of Magnet Valve leaking.
- (c) Leaking Magnet Valve Gasket.
- (d) Tension of Application Timing Valve Spring too low.
- (e) Sticking or sluggish Application Timing Valve.
- (f) Sticking or sluggish Application Pilot Valve.

Long release time—too long:

- (a) Pipe No. 4 supply choke restricted.
- (b) Sticking or sluggish Application Pilot Valve.

- (c) Leaking Pipe Nos. 4, 5, 14, 18.
- (d) Pilot Release Valve not seating.
- (e) Stop Reservoir Drain Cock leaking.
- (f) Leaking Gaskets.

Permanent suppression failure:

- (a) Leaking Pipe Nos. 19, 27.
- (b) Suppression Limiting Reservoir Drain Cock leaking.
- (c) Reduction Suppression or Reduction Insuring Valves not seating.

Short release time—too long:

- (a) Pipe No. 4 supply choke restricted.
- (b) Sticking or sluggish Application Pilot Valve.
- (c) Leaking Pipe Nos. 4, 5, 18.
- (d) Pilot Release Valve not seating.
- (e) Leaking Gaskets.

It is to be understood that the above are the most frequent failures and the probable cause for same. Failures may be encountered and causes for failures may be found that are not given in the above.

C. J. BODEMER,

Superintendent of Machinery.

Approved:

W. E. SMITH,

Vice-President & General Manager.