The Pennsylvania Railroad

SPECIAL INSTRUCTIONS
Governing Construction
and Maintenance of Signals
and Interlocking Plants
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SPECIAL INSTRUCTIONS GOVERNING CONSTRUCTION AND MAINTENANCE OF SIGNALS AND INTERLOCKING PLANTS.

1. Changes in C. S. E. 23 or its supplements must not be made to meet special conditions without approval of the Superintendent of Telegraph and Signals.

2. Supervisors of Telegraph and Signals or Telegraph and Signal Foremen must read over the C.S.E. 23-C with their men to insure that the various provisions are properly understood by all concerned.


4. “Signalman” in these instructions refers to the employe who operates the block or interlocking station, commonly termed “Operator.”

5. Signalmen, before being assigned to work at interlocking plants or block stations, upon request of their supervisory officer, must be examined and qualified by the supervisor of Telegraph and Signals or his representative. This qualification must include proper knowledge of C.S.E. 23 and other instructions applicable at the plant in question. The Supervisor of Telegraph and Signals must keep the supervisory officer of the Sig-
nalmen advised of any operating changes at interlocking plants and block stations.

6. Employes, except Helpers and Laborers, engaged in the construction or maintenance of signals and interlocking apparatus, must familiarize themselves with the current issues of Timetable, Book of Rules, and C.S.E. 23.

7. Employes must instruct their subordinates as to the necessity for safety, efficiency and economy, and that all work must be done in accordance with authorized practices.

8. Employes are responsible for the inspection, adjustment and proper maintenance of all signal and interlocking apparatus assigned to their care. They must promptly report to their superior any condition requiring his attention.

Instructions issued from time to time covering the inspection and testing of relays, indicators, electric locks, magnets and other apparatus, must be observed.

9. Alterations must not be made to any of the apparatus or circuits unless properly authorized.

10. Installation of experimental devices, or trial of unapproved material, must not be made unless specifically authorized.

11. When necessary to remove or disconnect any essential apparatus for replacement, repairs, inspection, testing or cleaning, train or engine movement must not be permitted over the route involved, unless levers and operating units affected are properly secured, or until the apparatus has been restored and
the devices are known to be in proper working order.

12. In case of changes in, failure of or damage to an interlocking or highway crossing warning device, the employe in charge must give the Signalman or Crossing Watchman full information concerning the apparatus affected, and arrange with him for the safe movement of traffic until repairs are completed.

13. Should a failure of switch, signal or device used in connection therewith be reported, and no cause found, the apparatus must be observed for a sufficient period to insure that it is operating properly. If the condition reported is of such a nature that the safety of operation is affected, precautions must be taken as outlined in Instruction No. 14. Tests and reports must be made under the direction of the Supervisor of Telegraph and Signals.

14. In case of train accident, immediate action must be taken as follows:
(a) Secure all signals, including distant signals, governing movements into that portion of track or tracks, which is or may be occupied or fouled by derailed or damaged equipment, so as to display their most restrictive indications, by disconnecting local controls at each signal, and seal the housings enclosing apparatus which may have been involved in the accident. After tracks have been cleared, signals may be restored to service under the direc-
tion of the Supervisor of Telegraph and Signals or his representative.

(b) If signals are found to have given false indication or if switches or other apparatus have not functioned properly, through failure of mechanism or controlling device, defective mechanism or device must be replaced under the direction of the Supervisor of Telegraph and Signals, and reserved under seal, without change or repairs, until inspected or otherwise directed by the Superintendent of Telegraph and Signals, or his representative. If the trouble is due to defective wiring or defective wires, they must not be removed, but may be disconnected from the terminals, and, after new wires are installed, housing must be sealed and evidence of failure preserved until the Superintendent of Telegraph and Signals, or his representative, has had an opportunity to make the desired inspection or test.

(c) If the proper sealing iron and seals are not immediately available to place the apparatus under seal, a competent person must be assigned to see that the apparatus, wiring or wires are not tampered with until seals are applied.

15. Regular inspection of protective features provided at sidings where inflammable liquids are loaded or unloaded must be made to insure that they are properly maintained
to function as intended. Inspection should be made at least once a month by the Maintainer of Telegraph and Signals and at least quarterly by the Telegraph and Signal Foreman unless otherwise provided.

16. Whenever electrical storms occur, Maintainer of Telegraph and Signals must immediately, if on duty, or as soon as possible after coming on duty, check ground meter readings, and, on extended sections, make a general survey of his territory by telephone, to Signalmen or other employees, to determine general condition of plant or section. Corrective action must be taken as necessary.

17. If track is found unsafe, due to broken rail, wide gauge, obstruction, or other conditions, signals governing over it must be secured to display their most restrictive indication, and immediate action taken to protect trains by flag, notifying the Track Foreman and proper authorities.

18. Where snow-melting oil or any heating device is used for melting snow and ice, extreme care must be exercised to avoid damage to wire ways, wires, insulations at switches, etc. When there is the appearance of damage or damage is known to have been done, a report must immediately be made to the Signalman and Maintainer of Telegraph and Signals and action taken to prevent any irregular operation of switches and signals that may result.

19. All binding posts and wire terminals in place must have their full complement of nuts and washers, which must be kept jammed. Care must be used to avoid undue
strain or damage to threads on binding posts, small machine screws and bolts.

20. Doors of housings, containing signals and interlocking devices, must be kept tight when closed to prevent water from entering; all unused openings must be filled to prevent the entrance of rodents or insects. Ventilators must be kept in good condition and clean to allow free circulation of air.

21. Trunking and other wire conduits must be kept in such condition as to prevent mechanical injury to the insulated wires and cables and to exclude rodents insofar as practicable. Vacant spaces in wire inlets and outlets of instrument cases, etc., must be packed tightly with genuine mineral wool. Wire and cable openings through floors, and other wire ways which would act as a flue to spread any fire which might occur, must be sealed with approved asbestos cement.

22. Extreme care must be used when drilling, filing or chipping metal parts in or near spring combination or other exposed electrical connections, and suitable safeguards provided to prevent particles lodging in apparatus and producing an unsafe condition. Care must also be used to prevent tools or other metal articles coming in contact with adjacent electrical connections. Broom straw or other non-conducting material must be used for the purpose of tracing or locating contacts in spring combination or other electrical apparatus.

INTERLOCKING MACHINES.

51. If units become in any way inoperative
or are disconnected, the Signalman must secure the controlling lever or levers by approved Blocking Devices (Plan S-522, current issue) and notify the Maintainer of Telegraph and Signals. When necessary to apply Blocking Devices on levers of electro-mechanical machines, they must be applied to both large and small levers.

52. Mechanical locking must not be removed or made ineffective, nor locking caps removed, unless properly authorized. When necessary to remove or change mechanical locking and until locking has been restored and is known to be correct, unless otherwise authorized by the Division Superintendent switches must be wedged and spiked, routes patrolled before any train or engine movement is permitted over them, the clear controls for the distant signals disconnected and all trains stopped at the home signal. If a defect develops, requiring the immediate removal of or change in the mechanical locking, the Division Superintendent and Supervisor of Telegraph and Signals must be notified at once.

53. State or other Governmental regulations applying to changes in interlocking must be observed.

54. Unless otherwise secured, the top of trunnions for swing dogs in mechanical locking of the S. & F. type must be slightly center punched to prevent the dogs from springing off the trunnions.

55. Machine parts, connections and devices affecting the operation of mechanical locking must be renewed as frequently as necessary
to insure reliable operation.

56. Quick switches must not be operated by hand for the purpose of permitting lever to be restored to previous position in the event of failure.

57. Quick switches must be regularly inspected for proper clearance and so maintained as to insure that the toggle springs are intact and have proper tension, and that there is no binding to prevent free operation.

58. Quick switches must operate after the lever is moved beyond the indicating point and before it reaches a point 3/16" from full normal or reverse position, measured by inserting a 3/16" gauge between lever and quadrant stop.

59. Electric locks on interlocking machine must not be released by hand, except in cases of emergency, or when necessary on account of repairs, and then only upon authority from the Division Superintendent or Supervisor of Telegraph and Signals. Whenever an electric lock is released by hand, notation must be made by the Train Dispatcher on the Train Sheet and by the Signalman on the Block Sheet. The Maintainer of Telegraph and Signals must make a detailed report on his Daily Report Sheet. After authority has been received to release a lock by hand, the following precautions must be taken:

**Signal Indication Locks.**

(a) If a signal lever cannot be restored to its normal position on account of the signal indication lock holding, the lock must not be released until the
Maintainer of Telegraph and Signals or Signalman knows that all signals directly controlled by the lever are in “Stop” position and all signals governing the approach to these signals are in their normal or a more restrictive position, except where the following precautions are taken:—

1. If the Maintainer of Telegraph and Signals or Signalman knows that the home signals controlling the affected lock are in the “Stop” position, an arrangement may be made by the Train Dispatcher to notify all trains governed by the distant signal controlling the lock affected that the signals are out of order, and to proceed as though the most restrictive indications were displayed, until examination has been made. Lock may then be released.

2. Examination must be made as soon as possible to determine whether the lock failed to release on account of signal failing at “Clear” or because of a defect in the indication circuit.

Switch Indication Locks.

(b) Switch indication locks may be released by hand after the switches have been properly secured and checked as prescribed by Instructions 104, 105 and 106.
Switch Lever Locks (Detector Locks).

(c) Electric switch lever locks (detector locks) may be released by hand after being certain that there is no train or engine on or approaching the switches controlled by the levers affected. Signal more favorable than Caution-slow-speed must not be displayed after the locks have been released until the track has been inspected, unless the switch lever light indicators show that the track is clear.

Traffic Lever Locks.

(d) Traffic lever locks may be released by hand after arrangements have been made with the Train Dispatcher to safeguard the movement of trains in the territory affected.

Electric Locks on Hand Operated Switches.

(e) Electric locks on hand operated switches may be released by hand after permission is procured from the Train Dispatcher.

60. Where electric locking is provided on a mechanical machine with Model 12 or similar electric locks, to lock the latch down, as in detector or similar locking, the segments of these locks must be cut and maintained so that, with one-fourth inch obstruction under the bottom of the latch rod, the locking dog of the electric lock will be free to drop to the locked position, and when in the locked position the latch cannot be raised more than a total of one-half an inch.
61. Where electrical locking is provided on a mechanical machine with Model 12 or similar electric locks, to lock the latch up, as in signal indication or similar locking, the segments of these locks must be so cut and adjusted that, with the latch held up by the electric lock, it must be up not less than five-eighths of an inch from its normal position, and with the latch raised and the lever normal the locking dog of the electric lock must not bind on the locking segment.

62. Where a lever is equipped with a mechanical stick push button circuit controller, this controller must be so adjusted as not to move toward the normal position enough to open the reverse contact until the lever has passed the indicating point going normal.

63. Cases on power and electro-mechanical machines and electric locks on mechanical machines must be kept locked. Guards and shields on electric locks, to prevent false manipulation, must be kept in proper position.

64. Keys to machine cases or apparatus, or seals on electric locks to make them available for manipulation by Signalmen, must not be provided, except those specifically authorized by the Superintendent and approved by the Superintendent of Telegraph and Signals.

65. The use of oil on latches, segments or trunnions of electric locks is prohibited.

66. The spring combination on electro-pneumatic and similar machines and the adjustment of contact springs and bands with relation to indication and electric locking must be carefully maintained as follows:—
(a) Only contact springs with a sharp (V-shape) bend instead of a gradual curve at contact point must be used, and the main stem of the spring must be straight so that any accidental bending during cleaning, or otherwise, will draw back rather than push forward the point of contact. All springs must be secured to the hard rubber bed plates by bolts that pass through the bed plate, and not more than two wires are to be connected to the same spring combination terminal post.

(b) Contact bands and springs must be cleaned periodically by wiping thoroughly with a clean dry cloth free from lint. Approved commercial cleaning cloths or chamois, moistened with oil, must be used as necessary to maintain clean contacts. Oil must be used very sparingly at relatively long intervals on the roller shaft bearings and must never be used on the bevel gears.

(c) Contact and roller surfaces which inadvertently become covered with an oil film must be cleaned by wiping with a clean cloth free from lint, to which a small amount of cleaning fluid, such as trichlorethelyne, carbon-tetrachloride or benzol has been added. These surfaces must then be rubbed carefully with a clean dry cloth, free from lint, to remove all traces of the cleaner and any re-
maining residue.

(d) Contact part of springs must meet the contact bands evenly and squarely in order to provide maximum contact. They must have sufficient pressure to provide good contact, but not enough to interfere with proper operation, especially of the quick switch. Checks must be made periodically to insure that all springs are closed or opened at the proper point in the lever movement.

(e) On levers with 60 degree roller travel, the normal and reverse switch control bands and NX and RY bands, for the control of switch repeating relays, must be on enlarged roller sections.

(f) Check the adjustment of each segment with the lever position, as determined by the quadrant, and adjust the segment, if necessary, so that with the lever at the indication, or locking point, on the quadrant, the locking tooth on the segment will clear the latch from .008 inch to .010 inch.

(g) To insure proper relation between segments and switch control bands, hold up reverse indication magnet and have the lever thrown so that the reverse safety tooth binds against and holds up the latch. With any lost motion, which may exist, taken out by turning the roller by hand, as far ahead toward the full reverse
position as possible, the reverse control band must be open a minimum of 1/32 inch (normal control band will be open slightly more). With the normal safety tooth binding the latch of the normal indication magnet and lost motion taken out of the roller toward the full normal position, the normal control band must be open 1/32 inch (reverse control band will be open slightly more). Be certain that the reverse control band is observed in connection with the reverse safety tooth, the normal control band in connection with the normal safety tooth, and that lost motion in the roller is forced in the proper direction.

(h) The “BD” band for the control of the lock magnet of Model 14 switch movement type valves must remain open when the lever is moved from either normal or reverse position against detector lock tooth. The “NX” and “RY” bands controlling switch repeating relays, where a back contact of this relay is used for energizing the lock magnet of Style “C” and “CP” valves, must remain closed with the lever against its detector lock tooth.

SIGNALS.

75. Signals must not be operated by hand for the movement of trains, except on written authority of the Superintendent. When necessary to operate signals by hand for tests, in-
spections or repairs, permission must be obtained from the Train Dispatcher.

**HIGHWAY GRADE CROSSING SIGNALS.**

80. The Maintainer of Telegraph and Signals must inspect and test highway grade crossing signal apparatus in accordance with outline given below. He must record on his regular C.S.E. 4 Daily Report where and when inspections are made, and must also record the tests and inspections shown below, conditions found and any corrective action taken, by number, in the C.S.E. 4 book located at the crossing (carbon copy to the Supervisor of Telegraph and Signals).

(a) At Least Once Each Two Weeks.

1. Inspect main and track batteries for height of electrolyte, condition of plates, connections and cleanliness.

2. Check degree of exhaustion of primary batteries, main and track.

3. Measure voltages of storage batteries, individual cell and overall, with charge on and signal not operating.
   (Designate cells 1, 2, 3, etc., from positive end of battery)

4. Measure total voltage of primary batteries after continuous load for five minutes.

5. Check A. C. power supply, including fuses.

6. Check operation of power-off relay.
7. Check operation of highway crossing signals for each track in each direction, and, after tests are completed, observe that both armatures of the interlocking relay are picked up.

**At Least Once Each Month.**

1. Check charging rate of main and track storage batteries simultaneously with power supply voltages.

2. Record on battery record card, water consumption, readings of voltages and charging rate.

**At Least Once Every Three Months.**

1. Check number of flashes per minute.

2. Check flasher contacts by observing if at least one lamp on each crossarm is burning with flasher relay at rest.

3. Take hydrometer reading of main and track storage battery cells of lead plate type, starting with No. 1 cell. Record specific gravity on battery record card.

4. Check visibility and focus of signals, and visibility and condition of signs (including R. R. advance warning signs on the highway).

5. Inspect all lamps for blackening of glass, replacing as required.

6. Check voltage at each lamp unit with normal power supply, lamps flashing. Voltage should be not
less than 10 nor more than 13.0 volts.

(d) At least Once Every Six Months.
The Telegraph and Signal Foreman, With the Maintainer of Telegraph and Signals, Must Make All the Above Inspections and Tests and, in Addition, Must:

1. Check voltage at the two lamps having lowest voltage reading under Tests (c)-6 with A.C. power supply off and with a shunt of approximately two (2) ohms across the storage battery after this shunt has been in place for approximately ten (10) minutes. Voltage at lamps should not be below ten (10) with lamps flashing.

2. Check back-flow of current through rectifier with power off.

81. A Maintainer of Telegraph and Signals being assigned a new section or additional territory, or temporarily relieving another Maintainer of Telegraph and Signals must make immediate study of highway crossing signal conditions.

82. Whenever severe electrical storms occur, an inspection of the highway crossing signals must be made by Maintainer or other Telegraph and Signal employe, under the direction of the Supervisor of Telegraph and Signals, or Telegraph and Signal Foreman, as promptly as consistent, to check all apparatus and power supply.

83. When highway crossing signals fail to properly indicate approach of trains, manual
crossing protection must be provided promptly and maintained until necessary repairs are made.

84. When there is an accident at a crossing protected by highway crossing signals, manual protection must be provided as soon as possible. The Maintainer of Telegraph and Signals must make necessary observations and tests, without opening the instrument case, to determine if the signals are working properly, and report conditions to the Supervisor of Telegraph and Signals. The Maintainer of Telegraph and Signals should, if possible, obtain the name and address of the person or persons injured, and of as many witnesses as possible. He must also obtain the license number of the vehicle involved.

SWITCH LAYOUTS.

101. Employes must not unlock switches that will in any way affect trains closely approaching or passing. Non-interlocked switches in main tracks, or leading to main tracks, when not in use, must be locked in normal position.

102. When parts of switch layouts, which may affect the adjustment and facing point locking of the switch, are repaired or replaced, or when adjustments are made in connection therewith, bar or obstruction test, in accordance with C.E. 40, must be made before switch is restored to normal service.

103. Detector bars shall be as follows:

(a) Detector bars shall provide fifty-five feet continuous protection to switches, derails and movable point frogs.
(b) Center of rail clips shall be placed eight inches and twenty-six inches, respectively, from the end of the bar and the intermediate clips spaced not more than three feet nine inches centers.

(c) Detector bars shall be so installed and maintained that they will rise at least three-fourths of an inch above the rail during locking and unlocking of switch.

(d) Clips and motion plates shall be kept tight and no excessive lost motion in operating connections shall be permitted.

104. When necessary to disconnect a switch, movable frog-point or derail (hereinafter called switch) from its operating mechanism, or to disconnect No. 1 switch rod, the following, in addition to providing complete protection for trains, must be done:—

(a) The closed point must be held securely against the stock or knuckle rail, by a spike driven in each of the first two ties back of the point, and where possible the spikes must pass through the tie plates.

(b) A standard wooden wedge, plan S-521 (current issue), must be driven between the open point and the stock or knuckle rail and be secured by, (1) a lag screw or heavy nail through one of the clip bolt holes, or (2) a piece of wood spiked to the first and second ties ahead of the point, or (3) a light flat headed bolt through a hole
in the wedge adjacent to the side of the first tie under the point and between this tie and No. 1 or head rod. The bolt must be secured in place by a cotter pin or split key below the bottom of wedge.

(c) If necessary to disconnect both No. 1 and No. 2 switch rods, train movements must not be made over the switch until one or both rods are properly connected to the switch points and the switch has been secured in accordance with 104(a) and (b). If the open point is removed, trailing movement may be made after the closed point has been secured in accordance with 104(a). For facing movements end of lead rail must be moved away from the running rail to provide at least five inches clearance and be provided with a riser wedge fastened to the tie and movements restricted to slow speed.

(d) If necessary to disconnect the switch rods of a switch in an interlocking, or if switch is in automatic territory, or is connected with a distant switch signal or switch indicator, the work must be done in charge of the Track Foreman in cooperation with the Maintainer of Telegraph and Signals.

(e) If switch is in an interlocking, the following also must be done:
1. The locking dog or plunger must be inserted through lock rod if possible.
2. The controlling lever of an interlocking machine, or the lever in a Centralized Traffic Control Machine, must be placed in the position corresponding to that of the switch. Interlocking levers must be secured by lever blocking devices which must not be removed nor levers operated until instructions to do so are received from the one in charge.

Switches equipped with dual control mechanism are essentially hand operated after the selector lever is placed in the hand operating position, and Instructions 104(e) do not apply. Before the selector lever is placed in the hand operating position the hand operating lever and the switch must correspond in position.

3. The power for power-operated switches must be cut off.

4. At a pneumatic switch a blow-off cock or union must be opened to prevent possible accumulation of pressure through leaky valves.

5. At an electric switch the motor brushes must be removed and the brush holders so secured that they cannot come in contact with the commutator, or, in lieu thereof, the fuse must be removed from the circuit supplying power to the master controller.

6. Power-operated switches must be kept spiked and wedged until the
power is again turned on so that an accidental change in the position of the valves or controlling apparatus or connections cannot cause the switch to go to the wrong position.

105. When necessary to disconnect locks, detector bars, circuits, or other safeguards in an interlocking, except mechanical locking (See Instruction 52), all switches affected must be safely secured before any train or engine is permitted to pass over them, as follows:

(a) The closed point must be held against the stock or knuckle rail by a spike in the head tie, and where possible, the spike must pass through the tie plate.

(b) A standard wooden wedge, plan S-521 (current issue) must be driven between the open point and the stock or knuckle rail.

(c) Special Instructions 104(e) must be followed.

(d) The Telegraph and Signal Foreman, Maintainer of Telegraph and Signals, or other Telegraph and Signal Department employe in charge will be held solely responsible for carrying out the above instructions.

(e) No movements are to be made over switches affected without the consent of the one in charge, and he must, upon completion of repairs, test levers by manipulation before surrendering jurisdiction over the machine.

106. Should any of the apparatus referred
to in Instructions 104 and 105 fail to function properly, Signalman shall restore any power operated switch lever, which, after several trials, has failed to go to the desired position, as far as possible toward the original position where it shall remain until instructions are received from the Maintainer of Telegraph and Signals. If no Maintainer is available Signalman shall notify the Dispatcher and be governed by local Divisional instructions. If, on electric switches the ammeter indicates excessively heavy current the lever shall be placed and left in the center position, except at electric interlockings where master controllers are used.

Unless the failure is very clearly of such a nature that repairs can be made by the Maintainer in less time than necessary to secure the switches in accordance with Instructions 105—(a), (b), and (c), the units involved must be secured in accordance with these instructions, except that where, due to excessive distance from the switch to the control point, it is impracticable to get the lever to correspond with the position of the switch, the lever must be put as far as possible toward the desired position and lever blocking devices applied.

After securing the switch, or switches, the routes affected must be patrolled through the group of switches adjacent thereto to ascertain that the route is properly set, each switch is secured and in safe condition for train movement and that there are no conflicting routes.

107. When, due to failure, switches have
been secured, movements over routes must be made at slow speed (until Leading Maintainer or higher authority has investigated conditions and authorized normal speed) as follows:—

(a) Where mechanically operated signals are in service—by clearance card.

(b) Where power operated signals are in service—by a signal not more favorable than Caution-slow-speed (Rule 278), which will necessitate opening the control of the track indicating relay where high or restricted speed routes are involved.

108. If necessary to disconnect a locking switch stand, switch circuit controller, combined plunger lock and circuit controller, or similar apparatus, from a non-interlocked switch, unless the switch is wedged and spiked in its normal position in accordance with Paragraph 104(a) and (b), or when such switches are open for inspection, adjustment or repair of such apparatus or of pipe-connected derails, the following precautions must be taken:—

(a) Control circuits or connections for signals involved must be so arranged that signals will display their most restrictive indications.

(b) Where telephone is available, arrange with Signalman to protect against train movements in both directions; where telephone is not available provide flag protection in both directions.

109. Electric locks on Type “G” and hand-
operated switch mechanisms must be regularly inspected to insure that all parts are intact and that working parts move freely.

110. Electric switch locks having indication circuits must be carefully inspected for missing or worn parts, which might render the lock-out feature inoperative; and the indication circuits must be tested in accordance with instructions for testing signal lock circuits insofar as these instructions apply.

111. Plungers and locking dogs must be full size at locking end. Corners at the ends of plungers and locking dogs, and the edges of openings in lock rods, must be kept sufficiently square to meet the requirements of Form C. E. 40, Report of Switch Inspection and Tests. The small openings in lock rods must not exceed the width of the locking dog or plunger by more than three-eighths of an inch.

112. Plungers must have at least eight inches stroke and must clear the lock rod when withdrawn not less than one inch nor more than one and one-half inches.

113. Where it is required that switches or derails be mechanically locked in one position only, the lock rod must be arranged with one locking opening.

114. Point detector with latch must be so adjusted that it will operate if the switch point is forced open three-eighths inch, with a maximum tolerance of one-eighth inch over. Point detector without latch must be adjusted to operate when switch point is forced open one-fourth inch.
BATTERIES IN FLOATING OR TRICKLE CHARGE SERVICE

NOTE: The term "floating" indicates battery directly connected across rectifier and load. The term "trickle charge" indicates battery connected across the rectifier, but to the main load only when alternating current power supply is off.

120. Jars or containers must be kept clean, level, and as dry as practicable.

121. Trays and supports must be kept clean, dry, and in such condition as to prevent surface leakage of current.

122. All connections must be kept clean and tight. Exposed brass or copper battery connections must be kept covered with a thin coating of vaseline or No-ox-id.

123. Battery housings or compartments must be kept clean and well ventilated. Where of wood or metal, the inside must be painted with acid-resisting paint.

124. Ventilating filling plugs must be maintained, properly secured in each cell.

125. Hydrometers and syringes must be properly protected against breakage and against injurious effects on the apparatus from acid. Separate syringe must be used for lead-acid type and for Nickel-Iron-Alkaline type of battery.

126. Distilled water, or water approved for use in batteries, must be kept in covered glass or porcelain containers. Containers of known capacity must be provided for adding water to batteries.

127. After tests and readings have been
completed, water must be added, if necessary to maintain proper solution level. When water is added in cold weather, solution must be agitated by use of the syringe to prevent freezing.

128. Electrolyte must be maintained at a level three-quarters of an inch above top of plates, or at electrolyte level mark.

**Lead Acid Type.**

129. Careful visual inspection must be made to detect broken, cracked or buckled plates, misplaced separators, or undue accumulation of sediment and for proper height of electrolyte.

130. Additional acid must not be added to replace losses due to evaporation. Electrolyte of the same specific gravity as that of balance of cells must be used in replacing loss.

131. In order that batteries may be kept properly charged, a minimum voltage of 2.16 per cell must be maintained with the charging current on. The specific gravity of the electrolyte should be in accordance with the manufacturers’ instructions.

**Nickel-Iron-Alkaline Type.**

132. The charging rate should be not less than 150 milliamperes more than the predeetermined average discharge in order to maintain maximum capacity. A minimum voltage across each cell of 1.5 when charging current is on must be maintained.

133. The manufacturer’s booklet, entitled “General Instructions for the Installation and Maintenance of Edison Storage Cells”, con-
tains recommended practice for installation and maintenance and instructions for cycle charging. If the battery is kept fully charged, cycle charging is not required.

134. Specific gravity at 70°F. should be not less than 1.157 nor more than 1.227. Consult the manufacturer's booklet for effects of temperature changes.

MECHANICAL PIPE AND WIRE LINES

140. Joints in pipe lines must be kept tight and properly riveted, and not more than one joint must be made in the same pipe between any two supports. With the lever in the center position of its stroke, the couplings must be located not less than twelve inches from pipe carriers.

141. Pipe casing through which wires and pipes are run must be free from water and kept filled with non-freezing oil. Stuffing boxes must be properly adjusted.

142. Two inches more throw must be maintained in the back wire than in the pull wire of wire-pulled signals.

TRACK CIRCUITS

151. Where track circuits are in use, the rails, rail fastenings, switch rods and connections must be kept clear of ballast and cinders.

152. When the head of the rail in track circuit territory is covered with rust, sand, coal, or any other material which may interfere with the proper shunting of the track circuit, and which cannot be immediately cleared, the Maintainer of Telegraph and Signals must notify the Signalman, in writing,
that such track circuits cannot be depended upon for the locking of specified switches, and that lever lights on levers involved must not be accepted as indicating that these track sections are clear.

Such levers must be secured by lever blocking devices in normal or reverse positions at all times, except during lever operation, and a “Rusty Rail” sign must be attached. Blocking devices must not be removed nor levers operated until it is known that train or engine movements are clear of the switches.

153. When rails, switch points, or frogs are removed, the Signal forces must secure the signals governing over them, so that they will display their most restrictive indications, and flag protection must be provided. Except for minor replacements (one or two rails, frog or switch point) the regular working order must not be restored until it is known that the track is safe and that rust does not prevent shunting of track circuits. This requirement will be met if the Maintainer of Telegraph and Signals, after track is ready for service and after assuring himself that block is clear, connects up the track relay and carefully observes its performance on the passage of trains and when trains are running through the block. The control wire for the relay should be held on the relay binding post so that circuit can be quickly opened on the passage of train should rust prevent the relay from operating properly. The relay must be observed a sufficient number of times to positively insure that it opens properly and remains open while the train is passing through.
the block.

154. Insulating rail joints must be kept clean and free from steel dust, and such tests made as may be specified to determine failure of insulation.

155. The voltage or current on track relays must not exceed the maximum specified in C.S.E. 32. A check must be made when tracks are raised or cleaned.

156. In electric traction territory the paths for the return of traction current must be opened only as authorized by proper authority. All paths must never be opened at the same time. When making renewals or repairs a return circuit for traction current must always be maintained.

157. Signal rail bonds removed from service on account of rail renewals and those removed on account of breakage, must be collected promptly, tied together in small bundles and disposed of as scrap.

158. When cars are stored on a track protected by automatic block signals, the Signalman handling the movement must notify the Maintainer of Telegraph and Signals, advising him of the limits of track on which traffic will be suspended as a result of the stored cars. The Maintainer of Telegraph and Signals must disconnect the track relays and track feeds within these limits as promptly as possible and also the control circuits of all high and restricted speed signals within the limits specified. In Cab Signal territory he must also disconnect the code transmitter control wire from the code control relay for
each track circuit occupied.

When the cars have been removed, the Maintainer of Telegraph and Signals must assure himself that the relays shunt properly and that the signals function as desired, before restoring normal operation.

159. When cars are stored within the limits of an interlocking, the Signalman must, with the Blocking Devices secure the levers controlling the track units and signals affected, in their proper position, and also the levers of such other units as may be necessary to insure that a signal cannot be given leading to the track or tracks involved. The Maintainer of Telegraph and Signals must be notified as promptly as possible and he must disconnect the track relays and feed wires to the track circuits, if used, and also the control wires to all high and restricted speed signals governing to such tracks.

When cars are being removed from the plant the Signalman must arrange for sufficient movement over the bonded section to insure proper shunting of the circuits. After the Maintainer of Telegraph and Signals has assured himself, by careful inspection, that normal conditions have been restored, he must so notify the Signalman, who may then remove the Blocking Devices and make such reports as are required.

160. When stored cars will affect the circuits of highway crossing protection, approach locking, annunciators, etc., the Maintainer of Telegraph and Signals must take all necessary precautions to safeguard the highway crossings affected and to insure safe
operation. When cars are removed, the Maintainer of Telegraph and Signals must restore normal working conditions as promptly as possible, after assuring himself that all the apparatus affected functions properly.

161. When stored cars are being removed from a storage track and the switch at the exit end of this track is interlocked or located near an interlocking, the levers in the route involved must be secured by Blocking Devices until movement is completed, to avoid improper operation due to false track circuit indication resulting from rusty wheels.

**CIRCUIT CHANGES AND TESTS INCIDENT THERETO.**

166. Alterations must not be made to any apparatus or circuits without proper authority. Revised plans must be procured from the Superintendent of Telegraph and Signals.

167. All changes must be made under direct supervision of a designated competent employe, who is personally responsible for work under paragraphs 168, 170 and 171, and must know that the employes making wire changes and connections are thoroughly qualified for and have full understanding of the work assigned them.

The man in charge must be responsible for the necessary local wiring diagrams, on which must be clearly indicated the apparatus wiring, etc., that is in service and that which is to be added. Points at which new circuits tie in with those in service must be plainly marked.

168. Any necessary relocation of apparatus and wiring in service, either permanent
or temporary, must be made under the personal direction of the one in charge, and all circuits interfered with in any way must be thoroughly tested immediately after relocation and before circuits are allowed to function for normal operation.

169. New apparatus must be located and new wiring placed and connected to the new apparatus, without disturbing work in service where possible.

170. New wiring through apparatus in service or tying to wiring in service must be handled under the personal direction of the man in charge. All wiring tied in to existing apparatus and circuits must be tested before tying in, to insure no interference with work in service.

171. Before final cut-over, all circuits must be thoroughly tested as far as possible, and final arrangement must be tested in entirety before being allowed to function for normal operation. This work must be handled under the personal direction of man in charge.

172. The man in charge must make necessary notations on wiring diagram to show any new wiring which is connected to working circuits or apparatus, and must clearly mark on his diagrams connections required for final arrangement which cannot be made prior to cut-over without interfering with work in service. Wires which are to be connected at cut-over must be marked with yellow tags. Wires which are to be removed at cut-over must be marked with red tags. Wires which, for any particular reason, cannot be hooked
up without special arrangement, must be marked with green tags. Wires bearing green tags must be connected only by the man in charge or under his specific instructions which shall definitely state that “green tag wires” are to be connected. On completion of changes, all colored tags must be removed.

173. When a revision involves additional levers in a machine, such levers must be secured against improper or unintentional operation.

174. The men engaged in making or testing circuit changes must have full understanding with Signalman as to any interference with working units, must obtain permission for necessary use of switches or signals, and must secure switches in accordance with Paragraph 105.

The man in charge of changes must cooperate with Maintainer of Telegraph and Signals so that the latter may be posted at all times as to the condition of the plant.

All work done in connection with making or testing signal and circuit changes must be in accordance with the other provisions of C.S.E. 23 insofar as they apply.

175. To provide a check against misunderstanding, when the man in charge directs another to make or break wire connections to wiring or apparatus in service, he must state specifically what is required, using wire number or other definite description, and, when possible, must indicate on the circuit plan or the wiring diagram the connection that is to be made or broken. If the open circuit is protected by a green tag, the one in charge must
so state. The one who is to carry out the instruction must repeat the order exactly as received, must not attach wires protected by green tag unless specifically directed, and after carrying out the order must advise in detail, using wire numbers, etc.

176. When circuits are to be closed only for test, the one assigned to this work should preferably remain at that point until the test is completed and then again open the circuit, reporting to the one in charge the exact conditions. The one in charge must, at the earliest opportunity, and before leaving the work, verify the conditions as reported.

177. All changes in interlocking and signal circuits must be given a detail check and all except very minor changes must be given a detail check by a supervisory employe, other than the employe in charge.

INSULATED WIRES AND CABLES

190. In order to avoid the possibility of damage to insulation, wires must not be crowded or jammed.

191. The insulation of wire must not be punctured for testing purposes.

192. Wire connections must be kept tight and clean, and wires properly marked, in accordance with authorized practice. Wires must be so arranged that they cannot foul moving parts.

193. Wires and cables, without metal sheath, in trunking and other open conduits, must be examined to detect physical damage, semi-annually in territory where trouble due to rats and mice has been experienced, and
annually at other points.

194. Braided aerial cables and messengers must be painted not less frequently than once every five years.

RELAYS, INDICATORS AND CIRCUIT CONTROLLERS

201. The inverting of relays or otherwise tilting them in order to close the contacts, or holding or fastening the contacts of indicators closed, is prohibited.

202. The bridging of contacts on relays, indicators or any circuit controlling device, or energizing relays or indicators direct from any source, which will in any way impair the protection of such circuit controlling device, must be done in accordance with the following instructions.

(a) The use of jumpers for the bridging of contacts is restricted to cases of absolute necessity, as when a switch and signal wire or apparatus is damaged, resulting from a wreck, dragging equipment, or similar occurrence; when A.C. signal power line trouble occurs; when signal power line is being tested; when necessary in connection with tests specified in C.S.E. 27, and when renewal of track structure cannot be taken care of otherwise, and then only to avoid unnecessary delay to trains. Generally, jumpers must not be used in connection with ordinary maintenance.

(b) When a condition, such as outlined, arises, making it necessary to use jumpers, the Supervisors and Assist-
ant Supervisors of Telegraph and Signals and the Telegraph and Signal Foremen, in the territory mentioned below, are permitted to authorize the use of jumpers after receiving authority from the Superintendent.

LONG ISLAND RAILROAD

“H” Interlocking (Harold Ave.) to “JE” interlocking, Jamaica, both inclusive.
Flatbush Ave., “FT” Interlocking, to “J” Interlocking, Jamaica, both inclusive.

NEW YORK DIVISION

From “H” Interlocking (Harold Ave.) to and including “Union” Interlocking, Rahway, N. J.
“Z” Interlocking, Jersey City, to “PB” Interlocking, Park Place, Newark, N. J., both inclusive.

PHILADELPHIA TERMINAL DIVISION

“A” Interlocking, Broad St. Station, to 30th St. Station.
“Broad” Interlocking, Broad St. Suburban Station, to North Philadelphia Interlocking, both inclusive.
30th St. Station to and including Overbrook Interlocking.
30th St. Station to and including Brill Interlocking.

PITTSBURGH DIVISION

Terminal area, “PH”, “US”, “UF” and “BU” Interlockings.

(c) When a condition arises in territory other than that designated necessitat-
ing the use of jumpers, their use must be authorized by the Supervisor or Assistant Supervisor of Telegraph and Signals, after receiving authority from the Superintendent.

(d) Before jumpers are applied to bridge any contacts, or to energize a relay or indicator by power direct from any source, either within or outside of interlocking limits, the Telegraph and Signal employe authorizing the placing of the jumpers must obtain the approval of the Superintendent. Whenever authority is given by the Superintendent for the application of jumpers, the Train Dispatcher or Train Director must make notation on the train sheet and the Signalman on the block sheet, and a blocking device placed on each interlocking switch and signal lever affected. Before jumpers are placed in territory outside of interlocking limits, the Signalman on each side of the location affected by the use of jumpers must, in addition to the Train Dispatcher or Train Director, have full knowledge that jumpers are to be applied and notations on the block sheet of their application must be made. When jumpers are used, either within or outside of Interlocking limits, the Signalman must make a message memorandum of the condition, explaining it to the Leverman, and post the memorandum in a conspicuous place. If
going off duty while the abnormal condition exists, he must bring it to the attention of the Signalman and Leverman who relieve him, fully explaining the condition to them. The memorandum sheet must not be filed until the Telegraph and Signal employee authorizing the use of jumpers has reported that normal conditions have been restored.

(e) When a Telegraph and Signal employee is instructed to place jumpers, he must remove jumpers immediately after the emergency no longer exists, and then he must report to the party giving the authority for the application of the jumpers that they have been removed, advising that normal conditions have been restored. The employee securing authority from the Superintendent for the application of jumpers must advise the Train Dispatcher or Train Director, and any other interested employee, that the jumpers have been removed and the switch and signal circuits restored to normal condition. Notation must be made by the Train Dispatcher or Train Director on the train sheet, and by the Signalman on the block sheet, of the removal of the jumpers.

(f) The Telegraph and Signal employee securing authority for the use of jumpers must make sure that they are not used for a longer period than necessary. The Telegraph and Signal em-
ploye instructed to apply the jumpers will be held personally responsible for their removal and must know that the switch and signal circuits have been restored to normal condition.

203. When applying jumpers for testing power line in A.C. automatic signal territory two (2) or more qualified employes must cooperate in their application and all must know that they have been removed.

204. Jumpers must be not less than eight (8) feet in length, of flexible wire not smaller than No. 16 A.W.G. and must not be coiled when applied. When not in use, they must be kept in a designated place and a check made to insure their having been returned each time they have been used.

205. The greatest possible care must be used in applying a jumper to keep to a minimum the amount of protection cut out by its use.

NOTE: The intention of these instructions is two-fold: first, to guard against improper use of jumpers; second, to insure their removal, even though precautions have been taken to render conditions entirely safe during their use. These instructions, therefore, apply regardless of whatever else may be done; such as disconnecting circuits, setting signals at "Stop", securing switches and levers, or other precautionary measures.

206. The insertion of insulating material between the contacts of circuit controllers to prevent shunting of track circuit, or the insertion of similar material in other contacts,
which would in any way impair any protective feature of any circuit, is prohibited.

207. The seals on relays and other similar apparatus must in no case be broken except by an authorized person. Relays removed from service, due to defect, must have a tag attached, stating defect, if known, and marked "not fit for service". They must not be used again until a tag is attached by Testman, stating "O.K. for Service".

208. Contact openings must be observed frequently and, if found more or less than normal, or otherwise defective, prompt replacement must be made.

209. "SS" relays and indicators must be observed as prescribed by current issue of C.S.E. 27, to determine if they are operating properly and promptly while the switch levers are being moved.

210. The following relays must operate as indicated for the normal position—where signals are controlled, the normal position must control the "clear" position of the signal.

(a) Model 15 Vane Relay—Vane must be up.

(b) Style TV-30 relays—Vane must rotate counter-clockwise.

(c) Radial Polyphase relay—Porcelain contact block must rotate counter-clockwise.

(d) D.C. Polar Relay.—
1. With polar armature operating in a horizontal plane—contacts must
2. With polar armature operating in a vertical plane—contacts must rotate clockwise, viewed from the front.

211. The Rotor and Stator of Radial Polyphase relays must be examined frequently to note that there is sufficient clearance when relay is deenergized and in both energized positions; also note that the tape on the field coils and magnets is not loose and liable to foul moving parts, and that no cracks have developed in the frames.

212. Switch circuit controllers must be kept clean and adjusted so as to operate within the prescribed limits for the circuits involved, and, where connected direct to switches, must, where practicable, be located on the side of the normally closed point. Where connected to hand-operated switches, at the point, they must be so adjusted that signals will display their most restrictive aspect when the switch points are open one-fourth inch or more. Where connected to mechanically interlocked switches, at the point, they must be so adjusted that circuits controlled will be open when the switch points are open one-fourth inch or more.

213. All circuit controllers must be kept clean and properly adjusted, and the original sets or bends of contact springs must, as far as possible, be maintained, and any excessive setting or bending which may produce an unsafe condition is prohibited.
214. When work is being done on polarized circuits, on relays or circuit controllers, only one wire must be off the binding posts at a time, or wires and posts must be clearly marked to avoid any possibility of reversing the circuit.

After wires are restored, circuit must be checked immediately to see that all apparatus involved is working properly and that proper polarity of circuits has been retained.

**DRAWBRIDGES**

226. Rail locks on drawbridges must be adjusted so that they cannot be locked with the rails raised one-fourth inch or more from their proper position.

227. Wedge locks on drawbridges must be kept adjusted so that they cannot be locked unless the wedges are within one-inch of their proper position.

228. Circuit controllers operated by surfacing wedges on drawbridges must be kept so adjusted that the circuit will not be completed unless the wedges are within one-inch of their proper position.

229. Apparatus and circuits for the protection of drawbridges must be maintained in accordance with these instructions and any special regulations applicable at the bridge in question.

**TESTS.**

251. Periodical tests of signaling and interlocking devices must be made regularly. The frequency of tests specified in current issue
of form C.S.E. 27 represents the maximum interval between tests. Local conditions may make more frequent tests advisable, in which case supplementary instructions will be issued by the Superintendent of Telegraph and Signals.

252. Other tests that may be designated from time to time must be made in accordance with instructions that will be issued in connection therewith.

253. When making electrical tests of switch and signal circuits, the proper meters must be used, and it must be known that no unsafe conditions are set up by the application of such testing apparatus.

When using switch or signal circuits for temporary telephone, it must be known that the use of the telephones will not, in any way, affect the circuits.

Approved: A. H. RUDD, Chief Signal Engineer.
