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Agency / Organization

CONRAIL

Title

Conrail - Special Instructions

CONRAIL

SPECIAL INSTRUCTIONS GOVERNING CONSTRUCTION AND MAINTENANCE OF SIGNALS AND INTERLOCKINGS

C&S 23

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SPECIAL INSTRUCTIONS GOVERNING CONSTRUCTION AND MAINTENANCE OF SIGNALS AND INTERLOCKINGS

CONTENTS

GENERAL INSTRUCTIONS

1. Employees engaged in the construction and/or maintenance of signals and interlockings must familiarize themselves with and obey the current issue of the following, including supplements:

a. Timetable
b. NORAC, NS, and CSX Operating Rules as applicable
c. Safety Rule Book
d. On Track Safety Manual
e. C&S 23 Special Instructions Governing Construction and Maintenance of Signals and Interlockings
f. C&S 27 Instructions for Making Tests of Signal Systems
g. C&S Standard Plans

2. Unless otherwise directed, Inspectors, Foreman, Assistant Inspectors, Electronic Technicians, Electronic Specialists, Maintainer Tests, Maintainers and Assistant Maintainers report to and receive instructions from the Supervisor.

3. Inspectors, Foremen, Electronic Technicians, Assistant Inspectors, Electronic Specialists, Maintainer Tests and Maintainers are responsible for the construction, inspection, adjustment and proper maintenance of all communications, signal, and interlocking apparatus assigned to their care. They shall see that all work is performed safely, efficiently, economically and in compliance with System Plans, Specifications and Standards.

4. Employees must conduct job briefings, observe and instruct their subordinates as to the necessity for safety, efficiency and economy, and that all work must be done in accordance with authorized practices.

5. Additions or alterations must not be made to any signal apparatus or circuits unless properly authorized.

6. Installation of experimental devices or use of unapproved material must not be made unless properly authorized.

7. Employees must report to their superior any situation or condition which may prevent completion of an assignment on schedule or within authorization.

8. Buildings and surroundings, the care of which is assigned to the C. & S. Department, must be kept in good order. Scrap material must not be allowed to accumulate around headquarters or other facilities. Scrap must be handled in accordance with current instructions.

9. Employees must keep the Operator or Dispatcher informed of any activity in which they are engaged that has any bearing or effect on the facilities in charge of the Operator or Dispatcher.

10. Malicious damage to signal facilities must be reported promptly to the Supervisor and Railroad Police.

11. Information regarding material or apparatus must not be given except when authorized by proper authority.

12. The Supervisor must report promptly any unusual occurrence, which may require special investigation.

13. When special conditions exist that are not covered by these instructions, the Supervisor shall issue local instructions.

14. When any changes are made, sufficient tests shall be performed promptly to assure signal system is functioning as intended.

15. When signal circuits are disarranged, a supervisory employee is required to perform service testing prior to returning signal system to service. This supervisory person must be an Inspector, Foreman, Asst. Inspector or Supervisor.

NOTE: Signal circuits are considered disarranged when more than one wire is disconnected or cut. This includes track wires.

16. The normal functioning of any device shall not be interfered with in testing or otherwise without first taking measures for insuring safety of train operation or highway traffic which depends on normal functioning of such device.

17. Defective apparatus that may endanger train or highway traffic movements must be immediately repaired or replaced if practicable. If it cannot be immediately repaired or replaced, its operation must be discontinued, the train and highway movements affected must be protected, and condition reported to the Dispatcher or Operator and Supervisor as soon as possible.

18. When any function of a signal system is to be taken out of service, Operator or Dispatcher must be notified and Form C. & S. 39 completed.

19. Permission must be obtained from Operator or Dispatcher and a full understanding had when apparatus affecting train operation is to be removed or disconnected. When necessary to remove or disconnect such apparatus for replacement, repairs, inspection, testing or cleaning, train or engine movement must not be permitted over routes involved, unless levers and operating units affected are properly secured or until the apparatus has been restored and operational check made to insure proper working order after repairs have been completed.

20. In case of changes in, failure of or damage to, signal or interlocking apparatus or highway crossing apparatus, the employee in charge must give the Operator, or Dispatcher, full information concerning the apparatus affected and arrange for the safe movement of traffic until repairs are completed.

21. Should a failure of switch, signal, highway crossing warning device, or device used in connection therewith be reported, and no cause found, appropriate tests must be performed to insure the device is functioning as intended.

22. Whenever electrical storm occurs, Maintainer must immediately, if on duty, or as soon as possible after coming on duty, make a general inspection of his territory and take corrective action as necessary.

23. If track is found unsafe due to broken rail, wide gauge, obstruction, or other conditions, signals (wayside and cab) governing movements over the unsafe track must be secured to display their most restrictive aspects, and immediate action taken to protect trains, notifying proper authorities. After corrections have been completed, signals may be restored to normal operation.

24. When oil pots or any other heating means for melting snow is in operation, Maintainer must look for possible damage to apparatus, wire-ways, wires and insulation at switches and action taken to prevent irregular operation of switches and signals.

25. Doors in housings containing signal and interlocking devices, must fit tightly when closed to prevent water, dust, foreign matter or snow from entering: all unused openings must be filled to prevent the entrance of rodents or insects. Ventilators must he kept in good condition and clean to allow free circulation of air.

26. Maintenance of apparatus not specifically covered in these instructions shall be in accordance with specific instructions issued for such apparatus. When not so covered, the manufacturer's instructions shall be followed.

27. Extreme care must be used when drilling, filing or chipping metal parts near exposed electrical connections, and suitable safeguards provided to prevent particles from 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. Non-conducting material must be used for the purpose of tracing or locating contacts in electrical apparatus. When drilling or driving nails in walls or partitions, care should be exercised to avoid damage to wire.

28. Interlocking or control machine, switch movements and other apparatus, shall be kept in good condition, free from excessive lost motion, rust, grease and dirt. Locking shall be kept clean. Bolts shall he kept tight and cotter pins properly spread. Contacts shall be kept clean and properly adjusted. Lubricants used shall be in accordance with manufacturer's instructions.

29. Bolts, nuts, dowels, screws, binding posts, rivets, nut locks, jam nuts, etc., must be kept in place, in good condition and tight. Care must be used to avoid unnecessary strain or damage to threads on binding posts, small machine screws and bolts.

30. Placing any object in instrument cases which is not an essential part of signal or interlocking equipment, is prohibited.

31. Communications and Signal Department employees must not line hand-operated switches for trainmen.

32. Extreme care must be taken when painting to prevent paint from settling where it will affect the electrical and mechanical characteristics of apparatus or equipment of the signal system.

SIGNALS

100. Signal lens and hood configuration must be in compliance with Plan CS 6010.

101. Signal lens, roundels, glass, marker, letter and number plates and lamps shall be cleaned as often as necessary to insure good aspects. Lamps should not be removed except for replacement or testing.

102. Broken or cracked lenses of color-light signals must be replaced as soon as practicable. If a red or yellow lens is broken so that the color is not plainly distinguishable, the signal must be arranged to display its most restrictive aspect by opening the control relay circuit. If lens for the most restrictive aspect is broken, lamp or lamps must be extinguished and Operator or Dispatcher and Supervisor notified.

103. Broken or cracked lenses of searchlight type signals must be replaced as soon as practicable. If mechanism cover glass, lens, or color discs are damaged, signal must be arranged to display its most restrictive aspect by opening the control relay circuit and mechanism replaced as soon as practicable. If signals most restrictive aspect is not plainly distinguishable, or hood is not in place, condition must be promptly corrected, or the light must be extinguished, and Operator or Dispatcher and Supervisor notified.

104. Broken or cracked lenses of position light signals must be replaced as soon as practicable. If signal's most restrictive aspect is not plainly distinguishable, condition must be promptly corrected, and if not possible to do so, the Operator or Dispatcher and Supervisor must be notified.

105. Ladder, hand railing, platform, foundation and/or fastenings shall be kept in good condition and securely fastened. Bolts, nuts, dowel pins, screws, binding posts, rivets, lock nuts, etc. must be kept tight and in good condition. The signal must be maintained in erect position.

106. Signals shall be aligned to give the best aspects warranted for approaching trains. Conditions, which may affect the reading of a signal aspect, must be promptly corrected or reported to the Operator or Dispatcher and Supervisor.

107. Prescribed lamp bulbs must be used and maintained at the specified voltage and replaced in accordance with current instructions.

108. Where spreadlight type lenses or deflecting prisms are used, they must be assembled, mounted, and maintained so that the beam spread is in the proper direction. All lamp units of the same signal head must have identical lens, deflecting prism or phankill arrangement. When necessary to replace such lenses, replacements shall be of the same kind.

109. Frequent inspections shall be made to avoid materials, snow, other surrounding lights, etc. interfering with view of signals. Tree limbs and foliage obstructing view of signals should be kept properly trimmed.

110. Signals must be painted periodically. Adjusting bolts and door fastenings must be lubricated to prevent rusting. Doors must be kept well gasketed and tightly closed to prevent water, dust or snow from entering. Where screened air vents are provided, they must be maintained so as to provide air circulation. Wire openings in signal units and masts must be sealed to prevent entrance of rodents, insects, etc.

111. Socket surfaces must be clean and bright. Lamp must be pressed into socket far enough to be turned clockwise to end of slot so that contact spring may force lamp into proper place. Lamp receptacles may be changed or reset only where proper provisions are available for refocusing.

112. Doors or cover of lamp unit must be kept closed when trains are closely approaching. If practicable, doors on same head of color light signals shall be fastened together so that all must be opened at the same time.

113. Searchlight mechanisms must be maintained in accordance with Instructions. Mechanisms must not be opened in the field, defective mechanisms must be replaced promptly, and emergency mechanisms kept ready for immediate use.

114. To secure a relay controlled signal so as to display its most restrictive aspect, the positive control wire must be disconnected from control relays, and in addition, if signal is of the relay or mechanism type, positive operating wire must be disconnected from the relay or mechanism. The wire or wires disconnected must be insulated from making inadvertent contact with other circuits.

115. To secure a solid state (Electro Code, HVLC) controlled signal, consult Signal Supervisor for instructions.

TRACK CIRCUITS

150. Bonding, including track circuit connections, shall be applied and maintained in condition to insure minimum resistance. Where bonds cross under rails of opposite polarity, they should be secured from movement by ballast or frost, which would result in an inadvertent short circuit. Bonds and track connections should be arranged to minimize hazard to damage by track work. Care should be exercised in use of staples, nails, or equivalent fastenings employed to track connections or bonds to prevent possible short circuit to a rail anchor, rail spike, or opposite the hole in a tie plate where inserting a future rail spike is possible. As far as possible, track connections and cross bonding shall be installed and maintained so as to remain visible and clear of ballast when necessary to cross under a rail. Temporary bonds shall not be installed.

151. For new work or rail renewals in track circuit territory, insulating rail joints shall be located per plan C&S-9012.

152. When the head of rail in track circuit territory is covered with rust, sand, coal or other material which may interfere with proper shunting of the track circuits and which cannot be immediately cleared, the Maintainer must notify the Operator or Dispatcher and complete Form C&S 151.

153. Before temporary track wires are installed, jumper permission must be obtained per C&S 23, Rules 301.

154. Track circuits shall be adjusted and maintained in accordance with the C&S27 test 21.

155. When rails, switch points, or frogs are removed, the Maintainer must secure all signals governing movements over them, so that they will display their most restrictive aspects. When rails, switch points, frogs are removed within limits of the approach circuits at highway crossings with warning devices, the Maintainer must take action to prevent unnecessary operation of such devices and provide for safe movement of highway traffic.

Except for minor replacements (one or two rails, frogs, or switch point), signal system must not be restored to normal service after rail renewal until it is known that the track is safe and that rust or other foreign material does not prevent shunting of track circuits. This requirement will be met if the Maintainer, after track is ready for service and after assuring himself that block is clear, connects the track relay and carefully observes its performance when trains are running through the block. The control wire should he held on the relay binding post so that relay can be quickly opened on the passage of train should rust, or foreign matter, 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.

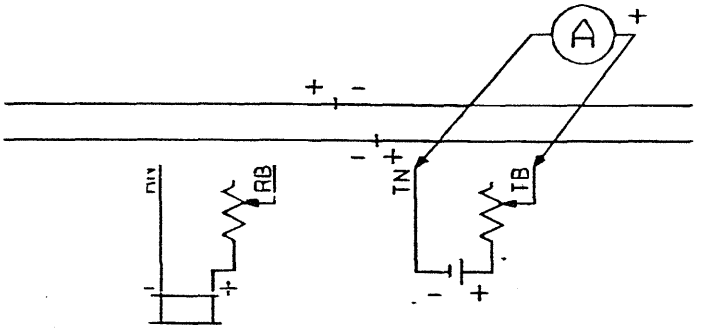
156. In electric traction territory, before disconnecting leads of impedance bonds or removing rails, frogs, etc., care should be exercised to insure at least one return path for traction current is maintained. When making rail renewals etc., before rail is disconnected, a return path for traction current shall be provided by using a temporary bond, Plan CS-2010 across the track each side of the rail section to be removed, making sure that no insulating rail joints interfere with this cross bonding circuit. Connections for electric traction return current shall not be made from one rail of a track to the rail of an adjacent track except between propulsion return rails where single rail propulsion return is employed.

157. When cars stored affect the circuits for highway crossing warning devices, the Maintainer must take all necessary precautions to safeguard the highway crossings affected. When the cars are removed, the Maintainer must restore circuits to normal operation and protect crossing until he has assured himself the crossing warning devices are working as intended.

158. PROCEDURES FOR TESTING PROPER CONNECTION OF TRACK WIRES

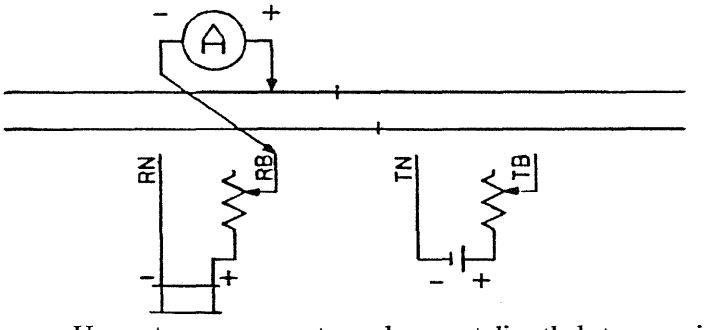
A. RELAY - BATTERY CUT

1. Assure all track wires are removed from the rails.



2. Battery End
   a. Use meter as an ammeter, 10-amp scale, and connect the meter leads to the track wires that are judged to be the feed end.
   b. A pair of track feed wires will be indicated by a current reading of two (2) amps and the polarity of the leads will be indicated by the meter (the red lead of the meter will indicate positive track wire).
   c. Open the track circuit feed in the instrument housing. If doing this causes the meter to read zero (0) current, then the wire tagging in the relay case where circuit was disconnected will verify the track circuit designation.

3. Relay End



   a. Use meter as an ammeter and connect directly between rails to determine circuit has energy applied and then in series with relay as shown.
   b. Correct pair of relay wires has been found when meter reads a value or current higher than working current of relay. Confirm that the correct relay is in the energized position.
   c. Open circuit at the track and observe that the correct relay has assumed the de-energized position.

4. Final
   a. Connect all track wires solidly to rails, as shown on plan.
   b. Observe that the signal governing train movement over circuit or circuits is displaying an aspect other than Stop and Proceed and observe that the signal and/or signals display Stop and Proceed as each circuit is individually shunted.

B. BATTERY - BATTERY CUT

1. Repeat Steps 2a through 2c inclusive to identify each track circuit and then perform Steps 4a and 4b.

C. RELAY -RELAY CUT

A. Repeat Steps 3a through 4b for each side of insulated joints.

WIRES and CABLES

200. In order to avoid the possibility of damage to insulation, wires must not be crowded or jammed. Wires must be protected from sharp edges. Wires must not be pulled around sharp corners or across sharp edges.

201. Wires and cables shall be without splices as far as practicable. Splices, where necessary, shall be in accordance with approved instructions

202. If cable conductors are not factory labeled the following applies, Cable conductors shall be numbered from core outward. When making splices, conductor #1 shall be joined to conductor #1, etc. When reading cables, face the conductors at each end, conductors of function cables at central instrument house end shall be read clockwise, and conductors at function end, counter clockwise. Cables outside interlocking limits and all express cables shall be read clockwise at the East or North end and counter clockwise at the West or South end.

203. Half splices of wires or cables are prohibited at any point for permanent construction. Branch connections shall be made in instrument cases, instrument houses, or terminal boxes.

204. Wires or cables entering interlocking buildings, instrument houses, or instrument cases shall be connected to terminals. Cables shall be terminated on a terminal board in conductor order, including spares. Conductor number one shall be placed at top or left-hand side of terminal board. All local wiring shall be installed on mating terminals and test links or straps employed to connect the cable conductors to the local wiring.

205. Jam nuts shall be used on threaded binding posts.

206. Wire conduits or chase-ways must be installed and maintained to prevent mechanical injury to the insulated wires and cables. Vacant spaces in wire openings of instrument cases, etc. must be packed tightly with approved sealing material. 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 sealing material.

207. Conduits and ducts between manholes or similar openings underground and junction boxes, instrument cases or similar housings above ground shall be sealed with an approved sealing compound to prevent cool damp air from entering housing and causing condensation.

208. Not more than two (2) wires shall be installed on an AAR terminal post, Two wires are permitted to be installed on relay posts of shelf or wall mounted relays.

209. Separate cables are to be run from the instrument house to each head of multiple head signals (except in the case of type "FA" dwarf signals which may be considered one unit) and to each switch machine on a crossover.

CHANGES AND TESTS

250. All changes must be made under the supervision of a designated competent employee, who is personally responsible for work under Paragraphs 253. 255 and 257, and must know that the employees 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 preparation of local wiring diagrams when required, 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.

251. At interlockings when changes are made that may interfere with the normal operation of the signal and interlocking system, the distant signals must be arranged so that they will not display an aspect more favorable than Approach and the switches spiked and wedged for all train movements until the changes are completed and checked. In cab signal territory, the cab signal aspect between the home and distant signal must not be more favorable than Approach.

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

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

254. Connections 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.

255. The man in charge must make necessary notations on wiring diagram or circuit plans to show any new wiring which is connected to working circuits or apparatus, and must clearly mark on his diagrams or circuit plans, 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 that shall definitely state that "green tag wires" are to be connected. Wires taken out of service shall be removed.

256. Before final cut-over, all circuits changed must be thoroughly tested as far as possible and final arrangement must be tested in entirety by a supervisory employee other than the man in charge.

257. The men engaged in making or testing circuit changes must have full understanding with Operator or Dispatcher 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 402. All signal testing and circuit changes must be in accordance with the other provisions of C&S 23 and C&S 27 insofar as they apply.

258. To provide a check against misunderstanding, when the man in charge directs another to close or open 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 closed or opened. If the open circuit is tagged by a green tag, the man 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 tagged by a green tag unless specifically directed, and after carrying out the order must advise in detail, using wire numbers, or other definite description, etc.

259. 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 opens the circuit, reporting to the man in charge the exact conditions. The man in charge must, at the earliest opportunity, and before leaving the work, verify the conditions as reported.

260. New wiring to working apparatus, relays or circuits must be secured or insulated from making inadvertent contact with circuits in service.

RELAYS AND CIRCUIT CONTROLLERS

300. The Inverting of relays or otherwise tilting them in order to close the contacts is prohibited.

301. The bridging of contacts of relays, indicators or any circuit controlling device or the direct energization of a relay to by-pass its intended control circuit is prohibited except as specifically authorized by the Supervisor Signals.

A. Such authority shall be granted only after:

1. A full and complete understanding is obtained concerning the conditions requiring the use of jumper. A jumper is a length of conductor used specifically to bridge a contact or contacts of relay indicators or any circuit controlling device or to energize a relay directly instead of thru its normal control circuit.

2. The effect on the operation is determined and the control levers for affected functions are placed in their proper positions and lever blocking devices applied.

3. The dispatcher and control operator are fully informed of the function, which is out of service, the effect on train operation and the length of time the condition is expected to exist. Form C&S 39 confirming the situation is to be filed with the dispatcher and control operator as soon as practicable.

B. The C&S employee so authorized to bridge a contact or energize a relay shall:

1. Identify such Jumpers so used with his initials and date and shall be held personally responsible for their proper application and removal after the need for using same has ended.

2. Make all necessary tests after removing jumpers used to bridge contacts or energize a relay to insure the apparatus is working as intended. On completion of such tests, he will notify the Supervisor C&S who shall nullify the C&S 39 form that had been filed.

302. Jumpers must not be 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.

303. 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.

304. 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, except when performing C&S 27 test 2-103A.

305. The seals on relays and other similar apparatus must in no case be broken, except by an authorized person.

306. 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 excessive setting or bending which may produce an unsafe condition is prohibited.

INTERLOCKING, TRAFFIC CONTROL SYSTEMS AND SWITCHES

400. Communications and Signal Department employees must not operate controls of an interlocking or remotely controlled signal facility except for test and inspection purposes or in an emergency and then only after a definite understanding with the Dispatcher.

401. When parts of switch layouts, which may affect the adjustment and locking of the switch, are repaired or replaced, or when adjustments are made in accordance therewith, Test 1-382 and Test 2-103 of the C.& S. 27, must be made as applicable before switch is restored to normal service.

402. When necessary to disconnect a switch, movable-point frog or derail (hereinafter called switch) from its operating mechanism, or to disconnect No. 1 switch rod, the following, as part of 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 on 45 ft. switches at the midpoint, and where possible the spikes must pass through the tie plates.

(b) A standard wooden wedge, Plan CS-2521 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.1rod or head rod. The bolt must be secured in place by a cotter pin or split key below the bottom of wedge. If new or extended work, a point clamp will also be installed (applies to power operated switches only) and locked.

(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 Paragraph 402 (a) and (b). If the open point is removed, trailing movement may be made after the closed point has been secured in accordance with Paragraph 402(a). For facing movements, end of load 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 made at restricted speed.

(d) If necessary to disconnect the Track Department switch rods of a switch in an interlocking, or if switch is in automatic territory, the work must be done under the direction of the Track Foreman in cooperation with the Maintainer.

403. When necessary to disconnect or impair function of locks, circuits, or other safeguards in an interlocking, 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 1 spike in the head tie, and on 45ft. switches at the mid-point: where possible, the spike must pass through the tie plate.
(b) A standard wooden wedge, Plan CS-2521, must be driven between the open point and the stock or knuckle rail.

404. Employees must not unlock switches that will in any way affect train movement.

405. Authority must be obtained from the Dispatcher before performing any work on a hand operated switch that will affect the signal system or the safety of train operations.

406. Upon completion of any work involving a power controlled switch or switches, the Maintainer and Operator or Dispatcher must insure that the switch is in its intended position and in correspondence with its control.

407. INSTRUCTIONS FOR ADJUSTING GRS MODEL 5 ELECTRIC SWITCH MACHINES

A. Adjust throw rod so that the points have proper pressure against the stock rail-both normal and reverse positions.

B. Point Detector-General

(1) Position lug on the short point detector rod in the center of the threaded section of the long point detector rod (Reference "A"). Run the nuts finger tight against each side.

(2) Position the lug on the point detector connecting rod in the center of threaded section of the long point detector rod (Reference "B"). Run the nuts finger tight against each side.

C. Point Detector-Long Detector Rod

(1) Loosen nuts on lock rods (Reference "D" and "E").

(2) Crank open switch point associated with long point-detector rod.

(3) Place 1/4inch obstruction gauge in switch point and float lock rod.

(4) Crank switch to close switch point and lock switch.

(5) Adjust long-point-detector rod at Reference "B" until point-detector contacts are open and shunt contacts are closed. Tighten rod nuts at Reference "B" and verify point detector contacts are still open and shunt contacts closed.

(6) Crank switch point open and remove1/4 inch obstruction gauge.

(7) Place 1/8 inch obstruction gauge in switch point, crank switch points closed and confirm point-detector contacts are made (closed) and shunt contacts are open.

(8) Crank switch point open, remove 1/8 inch obstruction.

(9) Crank switch points closed and confirm point detector contacts are made (closed) and shunt contacts are open. This completes long point-detector rod adjustment.

D. Point Detector - Short Detector Rod

(1) Crank open switch point associated with short point-detector rod.

(2) Place 1/4inch obstruction gauge in switch point and float lock rod.

(3) Crank switch machine to close switch points and lock switch.

(4) Adjust short point-detector rod at Reference "A" until point-detector contacts are open and shunt contacts are closed. Tighten rod nuts at Reference "A" and verify point detector contacts are still open and shunt contacts are closed.

(5) Crank switch point open and remove 1/4 inch obstruction gauge

(6) Place 1/8 inch obstruction gauge in switch point, crank switch points closed and confirm point-detector contacts are made (closed) and shunt contacts are open.

(7) Crank switch points open and remove 1/8inch obstruction gauge.
Crank switch points closed and confirm point detector contacts are made (closed) and shunt contacts are open. This completes short point-detector rod adjustment.

E. Lock Rods - General

(1) Position lug of the short lock rod (Reference "C") in the center of the threaded section of the long lock rod. Run the nuts finger tight against each side.

(2) Position lock connecting rod in center of front rod basket. Run the nuts finger tight against each side.

F. Lock Rods - Long

(1) With switch point open, insert 1/8inch obstruction.

(2) Crank the switch movement to the point position corresponding to the long lock rod. Assure that movement is not restricted and machine is locked.

(3) With machine locked, back off machine side adjustment nut (Reference "D") and move the long lock rod toward the track until rod is against lock dog.

(4) **With long rod against lock dog, run the track side , adjust nut (Reference "E") finger tight against lug. Tighten the machine side nut of the lock connecting rod.**

(5) With proper adjustment made, all nuts are to be drawn up tight to securely lock the adjustment.

G. Lock Rod - Short

(1) With switch point open, insert 1/8inch obstruction.

(2) Crank the switch movement to the point position corresponding with the short lock rod. Assure that movement is not restricted and machine is locked.

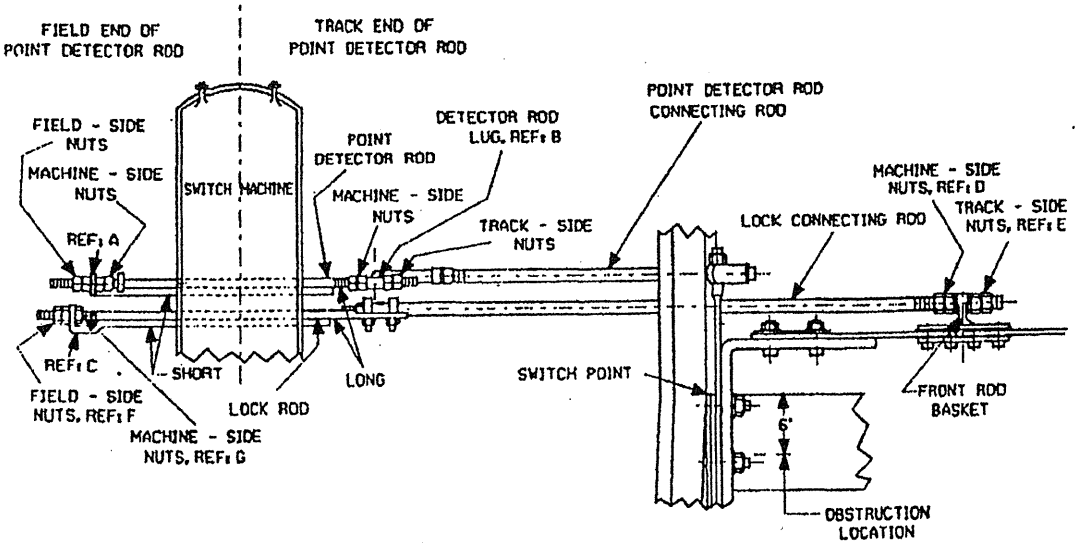
(2) With machine locked, back off machine side adjustment nut (Reference "G") and move the short lock rod toward the field until rod is against lock dog.

(3) **With short rod against lock dog, run the field side adjust nut (Reference "F") finger tight against lug on the short lock rod. Tighten nut (Reference "G") on the short lock rod.**

(4) With proper adjustment made, all nuts are to be drawn up tight to securely lock the adjustment.

H. Adjustment of lock rods shall be maintained so that the switch cannot be locked when a 1/4inch obstruction is placed between the switch points and the stock rail six inches back from the point of the switch and switch will lock with 1/8inch obstruction.

I. C&S 27 Test 1-382 switch obstruction is to be made at this time.



GRS MODEL 5 LAYOUT FOR
ADJUSTMENT OF LOCK & POINT DETECTOR RODS

407a. INSTRUCTIONS FOR ADJUSTING GRS MODEL 5 ELECTRIC SWITCH MACHINE CONNECTED TO LIFT TYPE DERAIL

A. Adjust throw rod so the derail is in the full derailing position and full non derailing position when required.

B. Point Detector-General
(1) Position lug on the short point detector rod in the center of the threaded section of the long point detector rod (Reference "A"). Run the nuts finger tight against each side.
(2) Position the lug on the point detector connecting rod in the center of threaded section of the long point detector rod (Reference "B"). Run the nuts finger tight against each side.

C. Point Detector-Long Detector Rod
(1) Loosen nuts on lock rods (Reference "D" and "E").
(2) Crank derail to full position associated with long point-detector rod.
(3) Ensure switch machine is locked.
(4) Adjust long-point-detector rod at Reference "B" until locating notch on top of point-detector rod, on field side, is flush with outside finished surface of frame. Tighten and lock nuts.
(5) This completes long point-detector rod adjustment.

D. Point Detector - Short Detector Rod
(1) Crank derail to full postion associated with short point-detector rod.
(2) Ensure switch machine is locked.
(3) Adjust short point-detector rod at Reference "A" until locating notch on top of short point detector rod , on track side, is flush with outside finished surface of frame. Tighten and lock nuts.
(4) This completes short point-detector rod adjustment.

E. Lock Rods - General
(1) Position lug of the short lock rod (Reference "C") in the center of the threaded section of the long lock rod. Run the nuts finger tight against each side.
(2) Position lock connecting rod in center of front rod basket. Run the nuts finger tight against each side.

F. Lock Rods - Long
(1) Crank the switch machine derail 2 inches off rail , place 1/2inch obstruction on rail under derail.
(2) Crank the switch movement to the full derailing corresponding to the long lock rod. Assure that movement is not restricted and machine is locked.
(3) With machine locked, back off machine side adjustment nut (Reference "D") and move the long lock rod toward the track until rod is against lock dog.
(4) With long rod against lock dog, tighten the machine side nut of the lock connecting rod.
(5) With proper adjustment made, all nuts are to be drawn up tight to securely lock the adjustment.

G. Lock Rod - Short
(1) With switch point open, insert 1/8inch obstruction.
(2) Crank the switch movement to the point position corresponding with the short lock rod. Assure that movement is not restricted and machine is locked.
(2) With machine locked, back off machine side adjustment nut (Reference "F") and move the short lock rod toward the field until rod is against lock dog.
(3) With short rod against lock dog, tighten nut (Reference "G") on the short lock rod.
(4) With proper adjustment made, all nuts are to be drawn up tight to securely lock the adjustment.

H. Adjustment of lock rods shall be maintained so that the switch cannot be locked when a 1/4inch obstruction is placed between the switch points and the stock rail six inches back from the point of the switch and switch will lock with 1/8inch obstruction.

I. C&S 27 Test 1-382 switch obstruction is to be made at this time.

408. INSTRUCTIONS FOR ADJUSTING US&S MODEL M3 AND M23B ELECTRIC SWITCH MACHINES

A. Adjust throw rod so that the points have proper pressure against the stock rail - both normal and reverse positions.

B. Point Detector - General

(1) Position the screw jaw on the point detector rod connecting rod in the center of threaded section of the point detector rod (Reference "B"). Run the nut finger tight against connecting rod jaw.

(2) Position the point detector rod sleeve in the center of the threaded section of the point detector rod (Reference "A"). Run the nuts finger tight against side of sleeve.

C. Point Detector adjustment with latchout feature.

(1) Use US&S gauge (PC 295326).

(2) With switch in reverse position, insert gauge between point detector bar shoulder and roller, adjust point detector bar so contacts are open and point detector is latched out and cannot be reset. Remove gauge and insure contacts remain open until latchout is reset.

(3) With switch in normal position, insert gauge between point detector rod sleeve and roller, adjust point detector rod sleeve same as above.

D. Point Detector Rod where latchout feature is NOT effective.

(1) Loosen nuts on associated lock rod.

(2) Crank open switch point associated with point detector rod.

(3) Place 1/4inch obstruction gauge in switch point and float lock rod.

(4) Crank switch machine to close switch points and lock switch.
Note: M23B Switches - Test will be made under power or by manual operation of clutch after throw bar has been disengaged and switch lever operated to desired position. Clutch may be operated by use of ratchet, CAUTION POWER MUST BE OPEN TO MOTOR BEFORE ATTEMPTING TO OPERATE CLUTCH MANUALLY.

(5) Adjust point detector rod at Reference "B" until point detector contacts are open. Tighten rod nuts at Reference "B" and verify contacts are still open.

(6) Crank switch points open, remove 1/4inch obstruction gauge and insert 1/8inch obstruction.

(8) Crank switch points closed and confirm point detector contacts are made (closed).

(9) Crank switch points open and remove 1/8inch obstruction.

(10) Crank switch points closed and confirm point detector contacts are made (closed).

E. Point Detector Rod Sleeve where latchout feature is NOT effective.

(1) Crank open switch point associated with point detector rod sleeve.

(2) Place 1/4inch obstruction gauge in switch point and float lock rod.

(3) Crank switch to close switch point and lock switch.

(4) Adjust point detector sleeve at Reference "A" until point detector contacts are open. Tighten rod nut at Reference "A" and verity contacts are still open.

(5) Crank switch points open, remove 1/4inch obstruction gauge and insert 1/8inch obstruction.

(6) Crank switch points closed and confirm point detector contacts are made (closed).

(7) Crank switch points open and remove 1/8inch obstruction.

(8) Crank switch points closed and confirm point detector contacts are made (closed).

(9) This completes point detector rod adjustments.

E. Lock Rods -General

(1) Position the bent lock rod (Reference "C") in the center of the lug. Run the nuts finger tight against each side.

F. Lock Rod -Straight

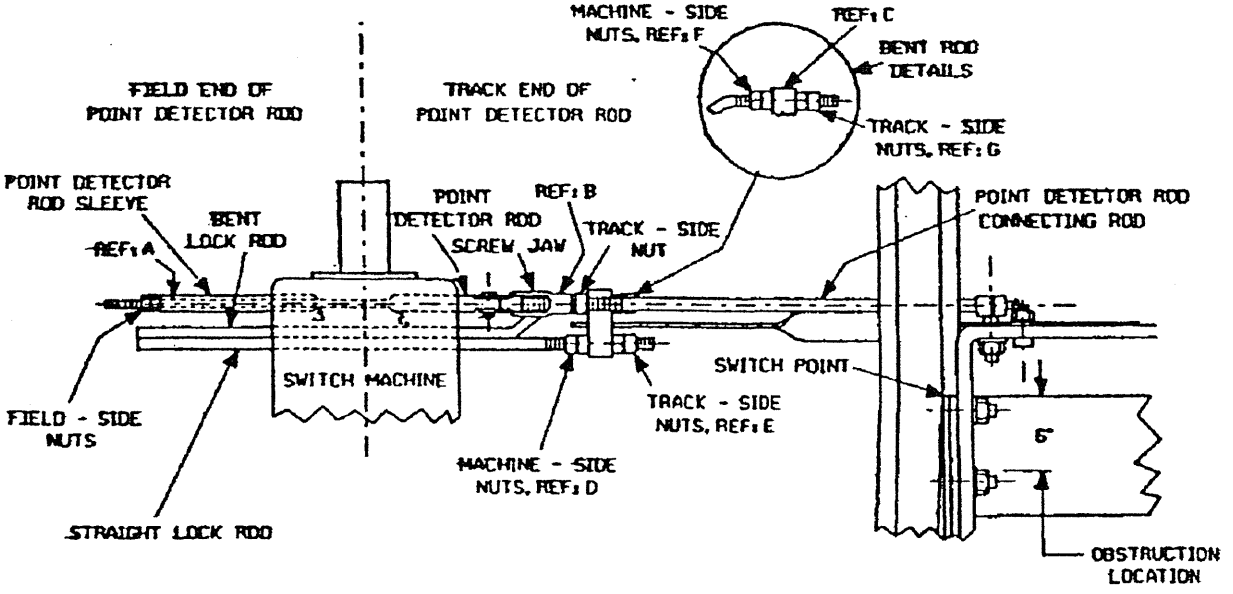
(1) With switch points open insert 1/8inch obstruction.
(2) Crank the switch movement to the point position corresponding to the straight lock rod. Ensure that movement is not restricted and machine is locked.
(3) With machine locked, back off machine side adjustment nut (Reference "D") and move the straight lock rod toward the track until rod is against lock bar.
(3) With straight rod against lock bar tighten the machine side nut of the straight lock rod.
(4) With proper adjustment made, all nuts are to be drawn up tight to securely lock the adjustment.

G. Lock Rod - Bent

(1) With switch points open insert 1/8inch obstruction.
(2) Crank the switch movement to the point position corresponding with the Bent lock rod. Assure that movement is not restricted and machine is locked.
(2) With machine locked, back off machine side adjustment nut (Reference "G") and move the bent lock rod toward the field until rod is against lock dog.
(3) With bent rod against lock dog, tighten nut (Reference "G") on the bent lock rod.
(4) With proper adjustment made, all nuts are to be drawn up tight to securely lock the adjustment.

H. Adjustment of lock rods shall be maintained so that the switch cannot be locked when a 1/4 inch obstruction is placed between the switch points and the stock rail six inches back from the point of the switch and switch will lock with 1/8inch obstruction.

I. C&S 27 Test 1-382 switch obstruction is to be made at this time.



US&S MODELS M2,M3, & M23 LAYOUT FOR ADJUSTMENT OF LOCK & POINT DETECTOR RODS

HIGHWAY GRADE CROSSING WARNING DEVICES

500. During snow or sleet storms, when conditions warrant, a check must be made of all electric crossing gates, and snow or ice sufficient to interfere with proper operation of the gates must be removed.

501. Procedure for aligning highway grade crossing signal, reflector type light units:

(a) Aligning Front Light Units

1. Open door so clear beam will be displayed.
2. Clean reflector and roundel. Assure that roundel is positioned correctly.
3. Light lamp continuously and assure lamp voltage is 8.5 to 9.5 Volts.
4. Adjust light unit vertically to align axis of beam 5'6" above pavement at a point 400 feet, where possible, in approach to the signal.
5. Adjust light unit horizontally to align axis of the beam to center of approach lane at a point 400 feet, where possible, in approach to the signal, maintain vertical alignment.
6. Tighten clamps and close door.
7. Repeat 1 through 6 on all other front light units.

(b) Aligning Back Light Units

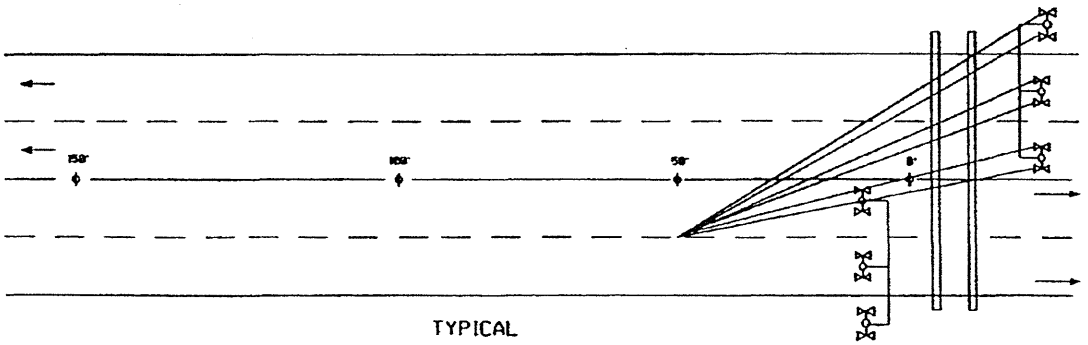
1. Open door so clear beam will be displayed.
2. Clean reflector and roundel, assure that roundel is positioned correctly.
3. Light lamp continuously and assure lamp voltage is 8.5 to 9.5 Volts.
4. Adjust light unit vertically to align axis of the beam 5' 6" above pavement at a point 50 feet in approach to the signal on the opposite side of the track.
5. Adjust light unit horizontally to align axis of the beam to a point 50 feet in approach to the signal on opposite side of the track and in the center of the approach lane, maintain vertical alignment.
6. Tighten clamps and close door.
7. Repeat 1 through 6 on all other back light units.

(c) Final check, observe that all light units are flashing and units are secured. Make sure all light units flash in unison, including gate lamps where applicable.

502. Standard Roundels

(a) Standard roundels have a 15-degree vertical spread and a 30-degree horizontal spread.

(b) Cantilever roundels have a standard vertical spread of 32 degrees, with a horizontal spread of 20degrees.



TYPICAL

PLAN VIEW SHOWING AREA OF MULTIPLE LANE HIGHWAY COVERED BY HORIZONTAL BACK LIGHT BEAMS WITH 20° SPREADLIGHT ROUNDELS ON CANTILEVER ARM.

FIG.1

503. Procedure for aligning, focusing and maintaining GRS LEX-C Highway crossing signal units.

CAUTION

The lamp receptacle in a GRS LEX-C crossing signal light unit is carefully positioned at the factory to precisely locate the lamp filament on the optical centerline at the reflector's focal point, thus producing maximum brilliance. If it becomes absolutely necessary to reposition the lamp receptacle, carefully follow the instructions under "Focusing" on the other side of this sheet.

The deep-dish parabolic reflector in the LEX-C unit is so efficient in gathering and reflecting light from the lamp filament that the beam may cause eye damage when viewed without the red lens in place. To avoid possible eye damage, either use protective eyewear, or reduce the lamp voltage just for the alignment procedure.

(1) The procedure for alignment of front lights is the same for mast mounted or cantilever mounted units.
   a. Apply energy to the front light unit to be aligned. Open door so clear beam will be displayed.
   b. Clean reflector and red lens.
   c. Adjust the light unit horizontally until to align axis of the beam to the center of the right-hand highway lane at a point 400 feet, where possible, in approach to the signal.
   d. Adjust light unit vertically to align the axis of the beam 5 feet 6 inches above the pavement.
   e. Close and fasten the door with the hex-head cap screw.
   f. Repeat the procedure outlined in steps a through f on other front light units.

(2) Back Light Units

   a. Apply energy to the back light unit to be aligned.
   b. Open door so clear beam will be displayed.
   c. Clean reflector and red lens.
   d. Adjust the light unit horizontally until to align axis of the beam to the center of the right-hand highway lane at a point 24 feet (12 feet for cantilever units) in approach to the signal on the opposite side of the track.
   e. Adjust light unit vertically to align the axis of the beam 5 feet 6 inches above the pavement.
   f. Close and fasten the door with the hex-head cap screw.
   g. Repeat the procedure outlined in steps a through f on other back light units.

504. (a) Gate arm torque adjustment must be checked each time that any change is made in gate arm, location of gate arm lamp, or any other alteration affecting the total weight of the assembly,

(b) Gate arm position must be properly adjusted to avoid a drooping gate arm when down and to avoid the possibility of travel beyond the desired raised position.

(c) Gate arms must be checked when in the raised position to avoid the possibility of arm fouling on wires, cables, trees, etc.

(d) Lubricants in accordance with manufacturer's recommendation must be used.

505. INSTRUCTIONS FOR THE APPLICATION OF MOTION SENSORS AND CONSTANT WARNING TIMING DEVICES TO CONTROL AUTOMATIC HIGHWAY GRADE CROSSING WARNING SYSTEMS

These instructions apply to the application and maintenance of motion sensors and constant warning timing devices (hereafter referred to as control devices) to automatic highway grade crossing warning devices. They set forth-general requirements representing recommended practice.

(A) Installation

1. Check shall be made that physical aspects of installation are in agreement with design plans.
2. Check shall be made to ensure all track circuit wiring is twisted (one (1) twist per foot) to minimize inductive coupling between adjacent circuits. Excess track circuit wiring and coiling shall be avoided.
3. Check shall be made that frequencies of equipment to be installed are compatible with existing equipment frequencies. Compatibility shall be determined from guidelines of manufacturers of all equipment in use.
4. Check of ballast resistance shall be made and compared to manufacturer's recommended approach distance limitations.
5. Check shall be made that termination shunts are of correct type and frequency. Check shall be made that termination shunts are installed at correct distance from crossing by actual measurement.
6. Check shall be made that all chokes, filters, and/or isolation units for signal track circuit equipment are of the correct type and installed in accordance with design plans. Check of normal operation of signal track circuit equipment shall be made both before and after installation of chokes, filters, and/or isolation units.
7. Check shall be made that all control devices and accessory devices are of correct type, model, and frequency. Check shall be made that circuit boards are of correct type and inserted in correct positions. Check shall be made that hardware programming devices (switches, jumpers, straps, resistors, PROMS, etc.) are in correct position.
8. Check shall be made that correct surge protection is installed as required by design plans.
9. Check of power supply for control devices shall be made before power is applied to motion sensors. Check shall include voltage, polarity, capacity, ripple voltage and state of charge of batteries.
10. Before initially applying power to control devices, all adjustments shall be preset to values recommended by manufacturer.
11. After initially applying power to control devices, software programming procedure (if applicable) shall be completed according to manufacturer's requirements.
12. Initial adjustment and/or setup procedures shall be completed according to manufacturer's requirements. Indications of meters, diagnostic indicators, etc., shall be recorded. Abnormal indications shall be corrected before beginning in-service testing.
13. If redundant control devices are installed, all checks and tests shall be performed on both normal and standby units. Correct operation of transfer unit (if provided) shall be checked.
14. Shunt tests and adjustments simulating train movements shall be made according to manufacturer's and railroad requirements. Tests shall be made in both directions on all tracks. Special tests for switches, if required, shall be made according to manufacturer's and railroad requirements.
15. Operation of highway traffic control system interconnection (if provided) shall be checked in accordance with highway traffic control cycle.
16. In signaled territory, all applicable tests shall be performed to verify correct operation of signal system.
17. Operation of crossing under train movement in both directions on all tracks shall be observed before placing crossing in service.

(B) Maintenance

1. Adjustment and setup procedure specified by manufacturer and an operation test (with approved shunts or train move observation(s) is to be made whenever changes are made in the control device(s) or its modules(s), track circuit(s), or wiring.
2. Except where expressly permitted, the power switch must be moved to the "OFF" position before removing, changing, or replacing modules within the control device.
3. When changing or replacing any modules within the control device, any site specific programming on the new module must be the same as was done on the original module.
4. Field repairs or modifications of control device or its module(s) are not to be made unless property authorized.
5. Results of inspections and tests herein required and all other inspections and tests including changes, repairs, or modifications are to be recorded on Form C&S 15.

INSTRUCTIONS GOVERNING HIGHWAY GRADE CROSSING ACCIDENTS AND WARNING DEVICE FAILURE

600. When automatic highway grade crossing warning devices are reported to have failed to indicate the approach of a train, alternate means of warning must be provided immediately and maintained until the warning devices have been checked and if necessary repairs made. An operational check must be made, prior to disturbing any apparatus, to determine if the warning devices failed to activate.

601. When there is an accident at a highway grade crossing with automatic warning devices, the Supervisor will be notified immediately and determine the appropriate tests to be made to insure the warning devices are functioning as intended.

602. If the accident involves serious injuries or fatalities all signal housings must be sealed. The seal numbers, time sealed and by whom must be recorded. The seals will not be removed until Asst. Chief Engineer C&S or his representative gives permission to remove the seals. When each seal is removed the time must be recorded. The position of all relays must be recorded. Before any signal apparatus is disturbed, an operational check must be performed. Before the warning devices are returned to normal service, repairs, if any, and appropriate tests must be preformed to insure the warning devices are functioning as intended.

INSTRUCTIONS GOVERNING REPORTED FALSE PROCEED INDICATIONS AND TRAIN ACCIDENTS

700. DEFINITIONS:

A. **False Proceed:** The failure of a signal, system, device or appliance to function as intended, which results in less restriction than is required or other condition hazardous to the movement of trains. The term "signal" shall apply to all cut sections in cab signal territory.

B. **Train:** Any equipment that is intended to produce a shunt across the rails.

701. POLICY:

All departments involved are responsible for furnishing full cooperation in the investigation and later preparation of related forms.

In case of a train accident, all signal apparatus and housings must be sealed tightly with Box Car type seals. Seal numbers, time and by whom must be recorded. These seals will not be broken until the Asst. Chief Engineer C&S, or his representative, arrives at the scene and gives permission to break the seal. When each seal is broken, a record will be kept of what time it was broken and the position of all relays recorded. It is the responsibility of the Supervisor-C&S to assure that all of his employees have sufficient amount of seals and approved shunts available.

Before any signal apparatus, housing, or circuitry is disturbed, an effort MUST BE MADE to reproduce the reported occurrence. All train movements, signals, switches and any other apparatus must be reproduced, as it was when the condition was reported. Shunt wires will be used to simulate the train movements and track conditions at the time of the occurrence. In case of alleged false proceed signal, this MAY BE DONE by Supervisor-C&S, or his representative. In case of a train accident, this MUST BE DONE by the Asst. Chief Engineer C&S, or his representative.

The Supervisor Signals or his representative will supervise the testing of the signal system. If FRA Inspector is present, the testing will be coordinated with him.

702. RESPONSIBILITIES:

A. The Superintendent shall promptly notify the Trainmaster, Road Foreman, and Assistant Chief Engineer C&S.

B. Train Dispatcher shall take immediate action by informing all trains involved that the alleged false proceed signal should be observed in its most restrictive indication.

C. The first C&S employee to arrive at the alleged false proceed signal will NOT open any signal cases or equipment, but will perform the following preliminary test:

1. Place an approved shunt to the rear of the alleged false proceed signal and observe and record the indication being displayed.
2. Place another approved shunt in advance of the alleged false proceed signal to ensure that it is displaying its most restrictive aspect and record the indication being displayed.
3. If any aspect other than the most restrictive is being displayed, the C&S employee will extinguish the signal by physically removing the lamp or lamps.
4. If any aspect other than the most restrictive is displayed at an interlocking signal, all switches and conflicting routes within the interlocking must be protected in addition to physically removing the lamp or lamps.
5. Remove the shunt that was applied to the rear of the alleged false proceed signal.

6. Check the signal to the rear of the alleged false proceed signal and ensure that it is displaying its proper aspect. This can be accomplished by placing an approved shunt to the rear of this signal, if signal is approach lit. Record indication being displayed.
7. Place another approved shunt in advance of this signal and ensure that the most restrictive aspect is displayed. Record indication being displayed.
8. The shunt that was applied to the rear of this signal can now be removed.
9. In 261territory, ensure that the opposing signal is displaying its most restrictive aspect.
10. A watch will be maintained and recorded until all tests are completed and it is determined that a false proceed did or did not occur.

D. The Supervisor-C&S shall then immediately notify the Assistant Chief Engineer-C&S of the circumstances.

E. Supervisor-C&S or his representative will coordinate train movements with Dispatcher.

F. The Supervisor-C&S-shall gather all information needed to analyze the false proceed.

G. The Supervisor or his representative will conduct the following:
1. Perform signal indication sequence check of signals involved.
2. Point check and break down all circuits involved with incident.
3. Perform all C&S 27 tests of the equipment that is associated with the failure.
4. Check for proper signal alignment, proper lenses, and proper hoods.
5. Check lamp voltage of all signals.
6. Make a general inspection of all equipment involved.
7. All tests performed must be recorded on the proper forms.
8. A detailed report of the investigation, with drawings as needed, shall be completed immediately after the investigation is complete and forwarded to the Asst. Chief Engineer C&S.

Yard Systems

800. TESTING AND MAINTENANCE OF ELECTRIC E160 CAR RETARDER AND YARDS

A. DAILY MAINTENANCE
(1) Class Yards - will be inspected (walked).
(2) Ground readings shall be taken on all energy busses.
(3) Wheel detectors are to be cleaned of dirt and magnetic particles.

B. WEEKLY MAINTENANCE
(1) Retarder
a. Adjust shoe spacing to average from 4-1/2" to 5" with retarder in No. 4 position.
b. Shim retarder for wear and uniformity. Check that the shim retainers are securely in place and are effective.
c. Lubricate all surface wear areas with Viscolite extra heavy oil or equivalent.
d. Check that all fasteners are tight and secured.

(2) Retarder Mechanism
a. Lubricate per manufacturer instructions.

(3) Switch Machines
a. Graphite Switches.
b. Observe that switch points move without excessive drag or spring.
c. Request track work when layout needs tamping.
d. Check for proper switch point pressure and that machine snubs properly.

(4) Wheel Detector
a. Check that all bolts, nuts, and clips are tight.
b. Check that detectors have not slipped from their proper positions.
c. Clear ballast and debris from detectors.

(8) Power Supplies
a. Check for proper voltages.

C. MONTHLY MAINTENANCE
(1) Mechanism
a. Check that operating current of each mechanism with no cars in the retarder is per manufacturer's specification.
b. Check that the motor brushes move freely and make contact on the commutator holders.
c. Check motor brushes for proper pressure per manufacturer's specification.
d. Check that the brush holders are properly aligned and each brush holder is approximately 1/8inch from the surface of the commutator.
e. Wipe commutator face with canvas or fine grade of rubber-bond type commutator stone.
f. Remove carbon dust from commutator and mechanism housings with a vacuum cleaner.
g. On hydraulic mechanisms check for leaks at the retarder and power unit, check oil level in reservoir, check temperature.
h. Check vacuum gauge to insure suction filter is not plugged and check to see unit cycles properly through 0-4 positions.

(2) Switch Machines
a. Perform C&S 27 test 1-382 (switch obstruction test) and lubricate per manufacturer instructions.
b. Check that restoring and snubbing functions are working properly.
c. Check circuit controller contacts for proper contact pressure, alignment, and cleanliness. Pitted contacts are to be replaced immediately.
d. Clean motor commutator bars, contact blocks and springs.
e. Remove carbon brush dirt from commutator housing.
f. Check that heaters are working during winter months.

(3) Weight Rail Detector
a. Check weight rail detector adjustment.
b. Check that weight rail is properly surfaced and free of moisture and dirt.

(4) Wheel Detector
a. Check alignment.

(5) Light Detector
a. Clean all lenses

(6) Presence Detector
a. Check that the loop is clear of debris and properly secured and that all connections are properly applied and insulated.
b. Check bonding within the loop and ensure compliance with C&S 400.
c. Check that the presence detector remains de-energized while loop is occupied.
d. Check that frequency and loop size are correct.

(7) Batteries
a. Test in accordance with C&S 23

D. BI-MONTHLY MAINTENANCE
(1) Mechanism Controller
a Check contacts in controller keep clean and ensure proper pressure per manufacturer's specification.
b. Check that mechanism wire outlet is properly sealed and no brake shoe dust is collecting on the terminal board.

E. QUARTERLY MAINTENANCE
(1) Retarders
a. Check spring rods for proper compression per manufacturer's specification.
b. Check chair and beam wear by determining vertical beam lift (maximum 1"). Check horizontal wear (maximum 2-1/2" shim wear). Vertical shoe beam lift should be done opposite the mechanism with the mechanism in the #2 or #3 position to represent a wheel in the retarder. (Accomplish by barring the wheel edge of the beam upward). Record on Form C&S 578.

(2) Insulation, Rail Joint and Switch
a. Test in accordance with C&S 27, Test 24.

(3) Distance to Coupling Circuit
a. Check to ensure circuits are working properly.

(4) Switch Machines
a. Check that restoring features on all applicable switch machines are working properly.

F. SEMI-ANNUAL MAINTENANCE

(1) Retarder

a. Check T-head portions of cross bar, and shim big end bearing if wear is not uniform.

(2) Switch Machines

a. Clean motor commutator bars.

G. ANNUAL MAINTENANCE

(1) Retarders

a. Clean debris and dirt from cribs and sub-assemblies.
b. Check that proper drainage is maintained.
c. Record the retarder measurements on Form 1522.
d. Check shoebeam lift on all shoebeams in the retarder. Record on Form CS 578.
e. Winter service, inspect mechanism gear housing for water accumulation, drain if required. Remove the caps under the housing to drain the lower bearings.

(2) Relay

a. Visually inspect all relays for excessive arcing and burnt contacts.

(3) Presence Detector

a. Check insulation resistance of loop. If insulation resistance is found at 200,000 ohms or less, it shall be repaired or replaced.

H. CHECKS AND TEST AFTER INITIAL INSTALLATION OF RETARDERS AND/OR RETARDERS MECHANISMS

(1) After the retarder has handled cars for several days, install shims where necessary to compensate for variation in shoe spacings.
Note: Except for initial installation period, shims are to be used to compensate for worn retarder parts. Readjusting of the throw rod compensates for shoe wear.

(2) After three (3) weeks of service or whenever retarder is reassembled, crank the mechanism to 145 dial setting and check the 25 9/16"dimension from the center of the eye on the throw rod to the mechanism side of the angle bar.

BATTERIES

900. PROCEDURE FOR INSTALLING, MAINTAINING AND TESTING SIGNAL STORAGE BATTERIES

A. Storage battery types covered

1. Lead Acid
2. Nickel-Iron Alkaline
3. Nickel Cadmium
4. Maintenance Free Lead Acid

B. Definitions

1. Storage Battery - A group of reversible or rechargeable secondary cells acting as a unit.
2. Approved Water - Water suitable for human consumption.
3. Floating Charge - A continuous input of current to a storage battery under load.
4. Initial Charge - A continuous input of current to a storage battery for the purpose of obtaining a gaseous state of charge.
5. Trickle Charge - A continuous input of current to a storage battery to overcome loss due to internal resistance.
6. Gaseous State of Charge - The production of gas (bubbles) in a storage battery when the charging current is continued after the battery is fully charged.
7. Specific Gravity - The ratio of the weight of battery electrolyte to the same volume of pure water at the same temperature.
8. Constant Current Rectifier - A regulated power source which acts to keep its output current constant regardless of load.
9. Constant Voltage Rectifier - A regulated, temperature compensated power source which acts to keep its output voltage at a value determined by the ambient temperature regardless of load.

C. Precautions

1. Cells must be unpacked carefully, keeping them in upright position. CELLS MUST NOT BE LIFTED BY POSTS OR COVERS. Lifting strap shall be used for cells up to 265 ampere hour.
2. After unpacking, check for physical damage. Electrolyte in cells must be examined to deter- mine that it is level with upper mark on jar. If electrolyte is below this point add approved water. If electrolyte is lower than 1 inch below the tops of the plates, the cells shall be considered to be defective.
3. Careful visual inspection must be made to detect broken, cracked, or buckled plates, misplaced separators, and accumulation of sediment, and for proper height of electrolyte.
4. When batteries are being charged, adequate ventilation and space must be provided to avoid pocketing of gases.
5. If acid electrolyte is spilled or surrounding areas are damp with acid, a solution of baking soda in the proportion of 1 lb. of soda to 1 gallon of water must be applied, after which the areas must be rinsed with water and dried. The soda solution must not be allowed to get into the cells.
6. If electrolyte comes into contact with the skin, it should be washed away promptly with water.
7. Caution must be used when moving cells or trays.
8. If batteries are to be stored, place in a dry, cool, clean location. Do not stack pallets of batteries.
9. Any open flame, sparks, or smoking material must not be allowed near a battery, as the gases expelled by the battery will explode.

D. Maintenance

1. Containers must be kept clean, dry as possible, and level.
2. Trays and supports must be kept clean, dry and in such condition as to prevent surface leakage of current.
3. All connections must be kept clean and tight. Battery connections must be kept covered with a thin coating of no-oxide grease.
4. Housings where batteries are kept must be clean and dry with proper ventilation provided.
5. Vent caps must be maintained and properly secured on each cell per manufacturers' instructions.
6. The electrolyte temperature of one cell may be considered as the electrolyte temperature of all cells in the same housing, provided individual cell voltages are approximately equal.
7. Batteries and battery housing must be discarded in accordance with prescribed manner only.
8. Batteries should be given initial charge before being placed in service.
9. Battery bus and intercell connectors should not come into contact with containers.
10. After tests and readings have been recorded, approved water must be added, if necessary, to maintain proper electrolyte level. When water is added in cold weather electrolyte must be agitated by use of syringe or hydrometer to prevent freezing.
11. DO NOT OVERFILL BATTERIES.
12. DO NOT OVERCHARGE BATTERIES (except initial charge).
13. Cells must be placed on approved rubber matting to avoid grounds and possible damage to cell containers.
14. Connections must be arranged so that the positive terminal of the charger is connected to the positive battery terminal.
15. Constant Voltage Charging Adjustment - To adjust constant voltage charger, disconnect the positive charger terminal from the battery and load. Connect an approved voltmeter to the positive (+) and negative (-) charger terminals and adjust the charger to the specified float voltage. The meter is then removed and the battery and load reconnected. Some chargers have a switch that selects the number of cells. This switch selection is acceptable.
16. Constant Current Charging Adjustment - To adjust constant current charger, connect an approved ammeter to read battery charging current as described below in Section E, Paragraph 4c, with normal load connected. Adjust the charger to provide the specified battery input current. Meter is then disconnected as described in Section E, Part 4c. If constant current charger setting is changed, input current and float voltage should be retested at next service date and readjusted if necessary. If specific gravity and/or float voltage in service are below recommended values when charger is set to specified battery input current, higher current setting is needed and charger should be adjusted accordingly.

E. Testing frequency

1. Interlockings and Automatic and Manual Highway Grade Crossing Warning Devices
   a. Voltage of main batteries and track cells shall be tested monthly.
   b. Battery input current and voltage of cells shall be tested every three months.
   c. Specific gravity (where applicable) shall be tested annually.
2. All Other Locations
   a. Voltage of main batteries, battery input current, and voltage of cells shall be tested every three months.
   b. Specific gravity (where applicable) shall be tested annually.

3. Instruments
   a. Meters - All tests shall be made with approved meters. Meters must be recalibrated annually. Care must be taken that meter is set to read the appropriate function (voltage or current) and to a scale greater than the maximum value expected. Approved meter is Simpson type TS-111.
   b. Meter Leads - Meter leads and test prods or clips shall use red for positive (+) and black for negative (-). Care must be taken that test leads have adequate insulation and cur- rent capacity to safely withstand the maximum voltages and currents to be measured. Approved meter leads are Simpson 0-7500.
   c. Hydrometers - Separate hydrometers shall be used for lead-acid and alkaline cells, and shall be marked to indicate intended use. Care shall be taken to keep hydrometers clean and dry.
4. Method of Testing
   a. AC Voltage Testing - Voltage of bus feeding battery chargers shall be measured. Voltage shall be measured by connecting one meter lead to each side of AG bus.
   b. DC Voltage Testing - Voltage of each cell and of entire battery shall be measured. Voltage shall be measured by connecting the positive (+) meter lead to the positive (+) battery or cell post, and the negative (-) meter lead to the negative (-) battery or cell post.
      CAUTION: AT LOCATIONS WITH ELECTRONIC EQUIPMENT, BATTERIES MUST NOT BE DISCONNECTED FROM BUSS UNLESS CONSTANT VOLTAGE CHARGER IS IN USE AND OPERATING PROPERLY OR ELECTRONIC EQUIPMENT IS SHUT OFF.
   c. Charging Current Testing - Charging current of each battery shall be measured. Charging current shall be measured by connecting the meter across the battery current test post, with the positive meter lead connected to the positive bus, and the negative (-) meter lead connected to the positive (+) battery post. After connecting the meter, the battery current test post is opened to take the measurement, then closed so that the meter leads may be removed.
   d. Specific Gravity Testing - Specific gravity of each cell shall be measured. Measurement shall be made by squeezing bulb of hydrometer, inserting hydrometer end into cell to be tested, and slowly releasing bulb to draw sufficient electrolyte to permit float to move freely in hydrometer tube. After reading is taken, bulb is squeezed slowly to return electrolyte to cell. Do not allow electrolyte to drip from hydrometer.
5. Record of Tests
   a. All Locations - Voltage, current, and, where applicable, specific gravity readings shall be recorded on Battery Record Report, form C&S 28.
   b. Highway Crossings - Voltage readings at highway crossings shall also be recorded on form C&S 15.

F. Battery Capacity for Signal Functions
   1. The following battery sizes will be used for the signal functions shown. Exceptions to this standard may be granted by the Asst.Chief Engineer - C&S to cover installations having unusual requirements.
      a. Switch Battery - 80 AH for HV and LV machines.
      b. Central Instrument House (Relay) - Based on approach lighted signals - 240 AH.
      c. Signal Locations (Relay): Where approach lit, 160 AH-Where steadily lit 240 AH.
      d. Code System Battery (Relay or Electronic) - 240 AH
      e. Gates and Flashers or Flashers Only - 240 AH.
      f. Track Cells - Conventional DC or coded track - 120 AH.
      g. Overlay Transmitter Locations - 1 or 2 transmitters, 80 AH - 3 or more transmitters, 160 AH.
      h. Overlay Island Circuits - 1 or 2 tracks, 80 AH - 3 or more tracks, 160 AH.
      i. Overlay Receivers - 1 receiver, 80 AH - 2 or more receivers, 160 AH.
      j. All other equipment-as shown on approved plan.

G.LEAD ACID TYPE

1. Installation
   a. Before connecting cells, all surfaces that are to be bolted together must be cleaned and coated with no-oxide grease. No-oxide grease must also be applied to the bolt and intercell connectors. If intercell connectors are not provided, No. 6 A.W.G. solid insulated wire must be used. After connections are made, surplus grease must be wiped off.
   b. Cells must be separated from each other and from contact with sides of battery shelter. Cells must be held in place to prevent movement which may cause breakage of intercell connections or battery terminals.
   c. After intercell connections are completed the voltage of each cell must be taken to determine that the positive (+) terminal of each cell is connected to the negative (-) terminal of the adjoining cell.
   d. The specific gravity of the electrolyte of each cell must be tested to determine that it is within the limits of 1.175 to 1.210 at 70 degrees F ambient temperature. Cells must not be placed in service until given an initial charge.
   e. The voltage (corrected for temperature) and specific gravity of each cell must be recorded on Battery Record Report, Form C&S 28, during initial charge. Cells are fully charged when voltage readings are obtained in excess of 2.25 volts per cell and the specific gravity readings are between 1.210 and 1.220. The output of the rectifier must be reduced until the voltage at cell terminals averages 2.15 volts per cell (corrected for temperature). The voltage may vary above or below these limits according to traffic conditions or power interruptions, but should not be continually above or below these limits except in cold weather when the voltage during the continuance of low temperature may be allowed to increase to the following values:

Electrolyte Temperature (F)	Volts Per Cell
60	2.19
50	2.22
40	2.26
30	2.30
20	2.33
10	2.37
0	2.40

   Cell voltage readings above are taken with the charger connected and charging at the normal float rate, (Specific gravity maintained at 1.210 - 1.220).

2. Maintenance
   a. If upon regular inspection, the specific gravity is found to be 1.175 or less, the batteries must be charged at the initial charging rate.
   b. A lead plate storage battery charged with a constant current rectifier requires a certain amount of current input to overcome loss of charge due to internal local action. This current input varies with the type and size of cell. The following table will be used as a guideline to float charge batteries in service:

Capacity, 8 hour rate (Amp-Hrs)	Input Rate (mils)
80	120
120	180
160	240
240	360
400	600

   c. If constant voltage rectifier is used, the rectifier output shall be adjusted to 2.2 volts per cell. This charging rate will not require seasonal rectifier adjustment.
   d. Plates must always be covered with electrolyte. If battery is being float charged properly, it should be necessary to add water only twice a year, preferably in the Fall and in the Spring to avoid the danger of water freezing during cold weather. When water is added, the level of the electrolyte must be filled to the upper level line on the side of the container. After adding water, allow 24 hours for the water to mix with the electrolyte before taking gravity readings.
   e. Terminal nuts must be checked periodically after installation to insure tight connections and cleanliness.

H. NICKEL IRON ALKALINE TYPE-MAINTENANCE

1. Filler caps must be kept closed except when necessary to have them open for watering, checking temperature, gravity, etc. Where cells are provided with screw type valve assemblies, knurled rings must be removed when cells are placed in service. Whenever cells are to be moved knurled rings are to be replaced.
2. The plates must be covered by electrolyte at all times.
3. The correct and minimum electrolyte levels for cells are as follows:

Cell Type	Correct Electrolyte Height Above Plate Tops	Minimum Electrolyte Height Above Plate Tops
"AH" (High Type Cells)	3"	1 ½"
"BH" (High Type Cells)	21/4"	1"
"A-B-N" (Low Type Cells)	1/2"	**must** cover plates

4. The surfaces of all terminals must be clean. Cells must be connected together with inter-cell connectors and inter-tray jumpers furnished for this purpose.
5. Cells must be permanently installed in the trays supplied and held in place to prevent movement.
6. Ensure all cells are fully charged before attempting to set the charger at the normal charging rate. After cells are fully charged, reduce as shown in table below:

CELL TYPE	Capacity, 8 hour Rate (Amp-Hours)	Input Rate (Mils)
N2	12	18
BI, BlH	20	30
B2, B2H	40	60
B4, B4H	80	120
B6, B6H	120	180
A4, A4H	160	240
A5, A5H	200	300
A6, A6H	240	360
A7, A7H	280	420
A8, A8H	320	480
Al 0, Al0H	400	600
Al 2, Al2H	480	720
A14, A14H	560	840
Al 6, Al 6H	640	960

7. The average cell voltage is 1.5 volts per cell at electrolyte temperature of 70 degrees F. The voltage shown in the following table is typical of float charged cells:

Electrolyte Temperature (F)	Volts Per Cell
80	1.48
70	1.50
60	1.52
50	1.55
40	1.58
30	1.60
20	1.61
10	1.62
0	1.63

8. A very light film of semaphore oil must be applied to the inner side of the valve housing, valve stem assembly, and top of cells to prevent corrosion. Care must be taken to avoid spilling oil into the cell.

I. NICKEL CADMIUM TYPE-MAINTENANCE

1. Use water only to clean cells.

2. Adjust floating charge (with constant current rectifier only) as per chart below:

Capacity, 8 hour rate (amp-hours)	Input Rate (mils)
80	120
120	180
160	240
180	270
240	360

3. The average cell voltage is 1.42 - 1.5 volts per cell at electrolyte temperature of 70 degrees F. The voltage shown in the following table is typical of float charged cells:

Electrolyte Temperature (F)	Volts Per Cell
80	1.48
70	1.50
60	1.52
50	1.55
40	1.58
30	1.60
20	1.61
10	1.62
0	1.63

J. ALCAD Nickel Cadmium

1. Commissioning charge
   a. Charge at 1.72 volts per cell for 15 hours
   b. Minimum equalize charge 1.49 volts per cell for 72 hours
2. Recommended charging voltage
   a. Float charge 1.45 volts per cell
   b. Equalize charge 1.49 volts per cell
   c. For applications, which require frequent cycling of the battery, raise the recommended float voltage to 1.48 volts per cell.

Cell Type	Capacity at 5 hour rate Amp Hours	Electrolyte per Cell Liters	Filling Pistol Spacer Number	Weight per Cell lbs
LPBOT	89	1.35	2	12.5
LP135T	128	1.79	2	16.1
LP160T	160	3.58	54	22.7
LP240T	252	2.88	54	25.8
L350P	347	4.83	54	38.8
LP400T	411	4.36	54	41.2

Torque: Connector nuts 619 Inch Pounds. Gland nuts 44 Inch Pounds.
Specific gravity -1.17-1.23. Potassium Hydroxide Electrolyte (Never add sulfuric Acid)

J. MAINTENANCE FREE LEAD ACID TYPE

1. Precautions

a. In normal use, the sealed battery will not release hydrogen gas, will not release acid mist, and will not leak acid. There is the possibility that under abnormal operating conditions, or as a result of damage, misuse and/or abuse, or overcharging, the above mentioned conditions could become present.
b. Sealed batteries contain sulfuric acid, which can burn or cause other serious injuries.
c. Batteries could generate gases which when released, can explode. If the safety vent opens while the gases are being generated, (in the event of a charger malfunction), these gases will be released.
d. Constant current rectifier must NOT be used.

K. MAINTENANCE

1. Since the sealed modules are shipped charged, there is the possibility that the cells will be in a pressurized state when received. Therefore, if battery modules do not have intercell separators, do not remove individual cells from module. If a defective or damaged cell is found, the entire module must be returned to the manufacturer for replacement of cell.
2. After initial charge of 2.4 volts per cell for 24 hours, batteries will then be float charged with a constant voltage charger to the following specified float voltages:

Type	Size	Volts per Cell		Volts per 6 Cells	
	(AH)	Range	Recommended	Range	Recommended
GNB	All	2.25-2.28	2.27	13.0-13.68	13.62
EXIDE	40-120	2.28-2.35	2.31	13.68-14.0	13.85
EXIDE	ALL OTHER	2.20-2.25	2.23	13.2-13.5	13.38

Note: If the charger that is being used does not have an external temperature probe to indicate exact cell temperature, Temperature Indicating adhesive strips that are located on one cell of each battery bank shall be used.