Massachusetts Bay Transportation Authority

Keolis Commuter Services

Railroad Operations

MBTA C&S 2

SPECIAL INSTRUCTIONS GOVERNING CONSTRUCTION AND MAINTENANCE OF SIGNALS AND INTERLOCKINGS

COMMUNICATION AND SIGNAL DEPARTMENT

SPECIAL INSTRUCTIONS GOVERNING CONSTRUCTION AND MAINTENANCE OF SIGNALS AND INTERLOCKINGS

The following instructions apply to all KCS employees affected by them, including all Supervisory and Engineering employees.

These instructions govern the construction, maintenance, operation and testing of all signal systems and apparatus including Interlockings, on MBTA Commuter Rail property and maintained by Keolis (KCS) and shall be obeyed by all employees whose duties are in any way affected by them.

These instructions are essentially related to and coordinated with the NORAC Operating Rules, C&S 1 Instructions for Testing Signal Apparatus and Signal Systems, and MW 1 Specifications for Construction and Maintenance of Track.

These instructions are intended to safeguard the movement of trains and must not be compromised in any way. These instructions are designed to continue to be effective in all kinds of emergencies, and authority will not be given to set them aside. In emergencies, the utmost cooperation shall be given to the General Manager or his / her representative in keeping him informed as to what can be done safely, consistent with these instructions.

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SECTION 1 GENERAL - ALL SYSTEMS

1) Employees whose duties are prescribed by these instructions must have a copy.

2) Employees engaged in the construction and/or maintenance of signals and interlockings must familiarize themselves with the current issues of the following, including all supplements:

   a. Timetable includes all applicable Division Notices and Bulletin Orders.

   b. NORAC - Operating Rules (or other Operating Rules in effect on territory for which responsible.)

   c. Safety Rules and Instructions - Maintenance of Way Employees.

   d. C&S 2 - Special Instructions Governing Construction and Maintenance of Signals and Interlockings.

   e. C&S 1 - Instructions for Testing Signal Apparatus and Signal Systems.

   f. *FRA Rules, Standards and Instructions for Signal Systems, Title 49 Code of Federal Regulations, Parts 233, 234, 235 and 236.*

   g. AMT 2 - (Electrified Territory only) Electrical Operating Instructions.

   h. KCS RWP rules and instructions.

   i. Federal hours of service rules.

3) Communication and Signal Department Employees shall be tested to maintain the following qualifications:

   a. C&S 2 - Special Instructions Governing Construction and Maintenance of Signals and Interlockings at least once in two years, not to exceed a 24-month interval,

   b. C&S 1 - Instructions for Testing Signal Apparatus and Signal Systems, at least once in two years, not to exceed a 24-month interval.

   c. AMT 2 - Electrical Operating Instructions, at least once in two years for employees subject to duty in electrified territory, not to exceed a 24-month interval.

   d. C&S Employees, except Helpers and Trainees shall be examined by Rules Examiner on NORAC Operating Rules (and/ or other Operating Rules in effect on territory for which responsible) and Timetable annually, and record maintained

   e. Roadway Worker Protection rules.

   f. Physical characteristics for territory responsible.

   g. Federal hours of service rules.

   Employees are responsible to attain and keep their qualifications up to date and will not be allowed to hold positions requiring those qualifications if they are not up to date.

4) Employees are responsible for the inspection, adjustment, and proper maintenance of all communications, signal, and interlocking apparatus assigned to their care. They must promptly report to their supervisor any condition requiring his/her attention.

5) Employees must cooperate with each other and with the employees of other departments to keep signal systems, devices and appliances in good working order.

6) Employees must observe and instruct their subordinates as to the necessity for safety, efficiency and economy, and that all work shall be done in accordance with authorized practices and standards.

7) Alterations or additions MUST NOT BE MADE to any individual component or system involving signal apparatus or circuits UNLESS PROPERLY AUTHORIZED.

8) Installation of experimental devices or use of unapproved material MUST NOT BE MADE UNLESS SPECIFICALLY AUTHORIZED By the Assistant Chief Engineer (ACE) C&S.

9) In these instructions, Roadmaster, Inspector, Foreman, Electronic Technician, Electronic Specialist, Maintainer, Signalman and Trainee refer to employees assigned to Communications and/ or Signals.

10) Senior Engineer C&S and C&S Roadmasters report to, receive instructions from, and are responsible to the ACE C&S in all technical matters relating to construction, maintenance, and performance of signal systems, devices and appliances assigned to them. They must cooperate with the General Manager in all matters relating to division operation insofar as the Communication and Signal Department function applies,

11) Unless otherwise directed, the Roadmaster shall have charge of communications and signal maintenance and construction on his assigned territory.

12) The Roadmaster must see that employees assigned to his jurisdiction qualify for the duties to which they are assigned and perform the work in a safe and efficient manner. He must see that these employees are provided with the required rules, plans, specifications and instructions, and that they fully understand and comply with them.

13) The Roadmaster reports to, receives instructions from and is responsible to the Senior Engineer C&S who reports to the ACE C&S.

14) Unless otherwise directed, Inspectors, Foremen and Maintainers report to and receive instructions from the Roadmaster. Electronic Technicians and Electronic Specialists report to the Manager of Control Systems.

15) Inspectors, Foremen, Electronic Technicians, Electronic Specialists and Maintainers are responsible for the construction, maintenance, and inspection of communications and/ or signal apparatus assigned to them. They shall see that work is performed efficiently, economically, and in compliance with System Plans, Specifications, and Standards.

16) Employees must report to the Roadmaster any situation or condition which may prevent completion of an assignment on schedule or within authorization.

17) Employees shall exercise proper care of tools, vehicles, equipment, and material assigned to them. In no event will requisitions be placed for material or tools in excess of immediate requirements.

18) The Roadmaster or his representative must make frequent examinations of tools and meters to ascertain that they are in proper order, of proper quality and condition. Tools, meters, keys, standard plans and instructions, catalogs and technical literature shall be issued to those who require their use. Employees are responsible for all tools, meters, and keys issued to them. Tools, meters, and keys issued by the Roadmaster shall be recorded on the appropriate form and signed for by the employee receiving them.

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

20) ACE C&S / Roadmaster must keep the General Manager advised of any operating changes at

interlocking and/ or block stations. C&S Department employees shall keep the Operator or Dispatcher informed of any activity in which they are engaged that may have any bearing or effect on the facilities in charge of the Operator or Dispatcher.

21) Malicious damage to signal facilities shall be reported promptly to the Roadmaster, Trouble Desk and railroad police.

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

23) a. Employees must report promptly any unusual occurrence which may require special investigation.

b. All failures to signal equipment, regardless of impact on train delays shall be reported to the Trouble Desk. A complete description of the cause of the failure and action taken shall be given to the employee on duty. In the event that the Trouble Desk cannot be reached Roadmaster should be advised.

24) When special conditions exist that are not covered by these instructions, local instructions shall be issued by the ACE C&S.

25) When any changes or adjustments are made, all applicable C&S 1 tests shall be performed promptly to assure signal system is functioning as intended. This applies to adjustments made as part of response to failures. Note particularly the requirements of C&S 1 Test 23.

26) Before signal circuits are modified in any way, all changes shall be properly authorized by the office of the Senior Engineer C&S Design or his designee. All changes shall be clearly shown on the circuit plans for the location, for the Roadmaster, and on the As-in-Service Plan to be sent to the Office of the Senior Engineer C&S Design for permanent circuit plan corrections to be made. If revisions are obtained via telephone or copied onto a valid circuit plan from a sketch or other authorized source, the date and initials of authorizing employee shall be shown with the revisions on each field copy, and the initials of the employee in charge in the field (who is also responsible for marking the plans) must also be shown with each revision on each copy. See Rules 250 through 263.

27) FRA Rules Standards and Instructions will govern except where KCS requirements are more restrictive.

28) PRINTED CIRCUIT BOARD HANDLING AND STORAGE PROCEDURES:

This plan deals with the handling and replacement procedures for all printed circuit boards associated with equipment related to vital signal systems.

The following steps are to be followed in the handling and replacement of all printed circuit boards.

a. When circumstances permit, a proper grounding device is to be used when handling or repairing all printed circuit boards.

b. All affected printed circuit boards located on KCS property are to be stored in either their respective chassis or in an 'anti-static' bag containing a 'Traveler Document' form SMCP-1000-2 and in a properly designated storage area.

c. When practical, all properly designated storage units containing printed circuit boards shall be grounded in a proper manner.

d. All affected printed circuit boards when moved between locations, will in addition to the

static bag, be placed in a proper storage container to protect said board from damage.

e. When transferring a printed circuit board from one location to another, all proper documentation is to be completed in its entirety.

'Proper Documentation' consists of all information required by the C&S Material Storehouse Dept. and is located in the KCS Handling Procedures HCMP-1000-1 policy document

29) PRINTED CIRCUIT BOARD REPLACEMENT PROCEDURES

Field replacement of defective printed circuit boards.

When troubleshooting a specific piece of equipment of the vital signal system all testing is to be coordinated through the dispatcher in charge of that territory involved.

Once the problem has been diagnosed to a particular printed circuit board and replacement is necessary, the following procedure is to be adhered too in making said replacement.

a. Reference the 'Minimum Modification Level' documents provided by the manufacturer for that specific board and ensure the replacement board meets the necessary requirements.

b. If a specific board contains software EPROMS that have to be 'swapped' to the replacement board, ensure that said EPROM information adheres to the application specific worksheets provided by the KCS Signal Design Dept. before proceeding with change.

   Any discrepancies are to be fully documented and notification made to the KCS Signal Design Dept. describing the discrepancies found.

c. Replace suspect printed circuit board following applicable handling procedures as described in 28) above.

d. Verify that the replacement printed circuit board corrects problem.

e. Test replacement printed circuit board according to the procedures listed in both the appropriate manufacturer's related service manual and KCS procedures listed in C&S 1 completing Test Form 27 when applicable.

f. Final step in the replacement procedure is to fill out a 'Traveler Document' (HCMP-1000-2) with the required information and return to either the C&S Material Storehouse Dept or the KCS ET Shop for repair. A copy of which shall be faxed to the Control Systems Manager at Cobble Hill (617-222-8250) in order to update the current KCS Hardware Database information.

30) HANDLING PROCEDURE FOR ALL FACTORY REPAIRED PRINTED CIRCUIT BOARDS

a. All printed circuit boards being returned to KCS by the manufacturer or an KCS authorized repair facility are to be tested by an Electronic Technician either in the shop or under live field conditions to ensure said board is working as intended.

b. Once the determination is made that the repaired printed circuit board is working as intended it will then be placed in a storage area as described under Part 1 of this document.

31) MANUFACTURER SERVICE BULLETENS

a. When the KCS Signal Design Dept receives a manufacturer's service bulletin related to equipment KCS has in service, they will contact both the ACE C&S and the Control Systems

Manager.

b. The Control Systems Manager will then coordinate with the Electronic Technicians or other employees as directed to ensure repairs or updates are performed in a timely and efficient manner.

c. All paper work related to the repairs or updates shall be kept on file in the office of the Control Systems Manager.

d. When all of the effected equipment has been repaired or updated the Control Systems Manager will then provide a written completion report to both Signal Design Dept and ACE C&S of the completion status.

50) Signal apparatus shall be kept in proper working order and maintained in accordance with current instructions and authorized practice.

51) 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.

When devices such as Track Interface Simulator (TIS) boxes, laptop computers and other test equipment are used for testing purposes, a check should be made to ensure that such test equipment does not introduce grounds or other interference with the proper function of the system under test. It may be necessary to power such devices with an isolated source.

52) Defective apparatus that may endanger train or highway traffic movements shall be immediately repaired or replaced, if practicable. If it cannot be immediately repaired or replaced, its operation shall be discontinued, the train and highway movements affected shall be protected and condition reported to the Dispatcher and Roadmaster by telephone.

53) When any function of signal system is to be taken out of service, Operator or Dispatcher shall be notified. The following steps shall be taken:

a. Permission shall be obtained from the Operator or Dispatcher and a full understanding reached 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 movements must not be permitted over routes involved unless operating units affected are properly secured. All apparatus affected must be completely restored and an operational check made to ensure proper working order after repairs have been completed.

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

56) Should a failure of a switch, signal, highway crossing warning device, or device used in connection therewith, be reported and no cause found, investigation must continue for a sufficient period to ensure apparatus is operating as intended. Results of all tests and observations shall be communicated to the Trouble Desk for follow up by Roadmaster. If the condition reported is of such a nature that the safety of operation is affected, precautions shall be taken as outlined in Rule 57. Tests and reports shall be made under the direction of the Roadmaster.

If a failure cannot be duplicated it may be prudent to contact the Electronic Specialists Desk at Cobble Hill to determine if a replay of the event could yield more clues to the failure.

57) **IN CASE OF TRAIN ACCIDENT,** immediate action shall be taken as follows:

a. Secure all signals (wayside and cab) including distant signals governing movements into that portion of tracks, which is occupied or may be occupied or fouled by derailed or damaged equipment. The local controls for each signal shall be disconnected, (see #118) and shall be set to display their most restrictive aspects. At Microprocessor Interlockings this requirement can be met by de-energizing the "V Stop" relays for each track. Roadmaster C&S shall be notified promptly.

b. If the accident is at an interlocking, the position of the interlocking and controlled

functions shall be recorded. If at a remotely controlled signal facility, the positions of switches, signals, and control relays for such switches and signals shall be recorded. If a recorder is in service, ensure that it is secured against possible tampering until proper authority obtains a valid printout.

c. If the accident is at a highway crossing equipped with automatic devices, the position of all of the vital devices need to be recorded. Where apparatus has been damaged, the crossing shall be protected until repairs have been made. If a recorder is in service, ensure that it is secured against possible tampering until proper authority obtains a valid printout. Lastly, an operational test of the installation shall be made to check that apparatus is functioning properly.

d. If the accident involves a personal injury or fatality, or if signals are found or suspected of having given false indication, or if switches or other apparatus have not functioned properly, or, as instructed by supervisory personnel, the housing enclosing the apparatus which may be involved in the accident shall be sealed without change or repair until inspected or otherwise directed by the ACE C&S or his representative. A competent person shall be assigned to see that the apparatus, wiring or wires are not tampered with.

e. Where an accident results from signal failure, the FRA shall be notified by the ACE C&S or his representative within 24 hours of occurrence by telephone, (800) 424-0201, in accordance with 49 CFR 233.5.

Whenever an electrical storm occurs, the Maintainer must immediately, if on duty, or as soon as possible after coming on duty, conduct ground tests and, on extended sections, make an initial survey of his territory to determine the general condition of their interlockings or their section. In case of severe storm, an inspection should be made as soon as practicable and corrective action taken as necessary. Additionally, the Maintainer should inspect at-grade crossings looking at the power off lights to make sure power is still on at the crossings.

58) 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 shall be set to display their most restrictive aspects, and immediate action taken to safeguard the movement of trains through the affected area by notifying proper authorities. After corrections have been completed, signals may be restored and operational check s made to ensure that normal operation has been re-established. It may be prudent to pull grade crossing normal plugs, located in the affected block out, as an interim emergency measure to put signals to red, but this should not be used as a substitute for securing signals (see #118).

59) (DELETED)

60) Doors in housings containing signal and interlocking devices must fit tight and result in a weatherproof seal that prevents undesired matter from entering the housing. All unused openings shall be properly sealed to prevent the entrance of rodents or insects. Ventilators shall be kept in good condition and cleaned to allow free circulation of air. Space between the housings and the ground where cables enter housings should be kept clear from any combustible material.

61) Extreme care shall 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 from lodging in apparatus and producing an unsafe condition. Care must

also be used to prevent tools or other metal articles from coming in contact with adjacent electrical connections. Broom straw or other non-conducting material shall be used for the purpose of tracing or locating contacts in spring combinations or other electrical apparatus. When drilling or driving nails in walls or partitions, care should be exercised to avoid damage to wire.

62) Interlocking or control machines, switch movements, and other appurtenances, shall be kept in good condition, free from excessive motion, rust, grease and dirt. Levers and locking shall be kept clean. All bearing parts shall be kept lubricated, but excessive lubrication should be avoided. Bolts and dowel pins shall be kept tight, cotters properly spread Contacts shall be kept clean and properly adjusted. Lubricants used shall be in accordance with KCS Lubricant Approved List.

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

64) Deleted

66) Placing any object in an instrument case that is not an essential part of signal or interlocking system is prohibited. Flammable materials are not to be stored in or close to any signal enclosures under any circumstances.

67) Joints and rivets in signal pipe lines shall be kept tight. Pipes shall be fully screwed into couplings and both ends of each pipe shall be riveted to pipe plug with two rivets. Not more than one joint may be made in the same pipe between any two supports. With the lever in center position, the coupling shall be located not less than 12 inches from pipe carriers.

68) Deleted

69) Cranks, compensators, and other mechanical connections shall work freely, but shall not have excessive lost motion in moving parts. They shall be kept clean, properly centered, lubricated, and in alignment.

70) 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.

71) Communication and Signal Department employees must not throw and lin hand operated switches or operate bolt lock levers for trainmen. Hand operated switches should only be operated for test purposes or as directed by Roadmaster C&S. test purposes.

72) When in the course of construction, switch points are installed in signaled track prior to placing such switch in service, the switch points shall be secured in accordance with Rule 406. In addition, a switch circuit controller shall be installed and wired to open the signal control circuits for both wayside and cab signals when the switch points are open ¼ of an inch or more. Circuit controllers on crossover switches shall open the signal control circuits for both wayside and cab signals on both tracks in which switches are located when either or both switches are open ¼ of an inch or more.

73) Extreme care shall be taken when painting to prevent paint from settling where it will affect the electrical, optical and mechanical characteristics of apparatus or equipment of the signal system.

SECTION 3 FALSE PROCEED INVESTIGATION

75) The ACE C&S or Senior Engineer C&S shall be notified immediately in the case of any alleged false proceed or signal run-by, i.e., a train failing to stop at a stop indication. If in doubt the Trouble Desk should notify the Roadmaster C&S to ascertain if the report is valid.

76) **All** Reports of alleged false proceed signals or a train violating a "Stop" signal aspect shall be immediately reported to a Roadmaster C&S and investigated. The signal or signals shall be immediately secured so as to display their most restrictive aspects and approach signals shall be arranged so they cannot display an indication more favorable than approach until an investigation has been completed and it has been determined that it is safe to return them to service.

77) Investigation of false proceeds or a train violating a "Stop" signal aspect shall be in accordance with C&S 1, Test 23C. Form C&S 27, Test 23C shall be filled out by Roadmaster C&S or Senior Engineer C&S for all alleged false proceeds or signal run-by and submitted to the Office of the ACE C&S within 7 days of the occurrence where possible.

SECTION 4 SIGNALS

101) Signal lens, roundels, glass, marker, letter and number plates and lamps, shall be cleaned as often as necessary, to ensure good aspects. Lamps should not be removed except for replacement or testing, or when aspect is out of service. Hoods shall be maintained at all times. Backgrounds shall be painted flat black and kept in good condition at all times.

102) Broken or cracked lenses of color light signals shall be replaced as soon as practicable. If a red or yellow lens is broken so that the color is not plainly distinguishable, the signal shall be arranged to display it's most restrictive aspect by opening the control relay circuit. If the lens for the most restrictive aspect is broken, or its hood is not in place, the condition shall be promptly corrected, or the lamp or lamps shall be extinguished and the Dispatcher or Operator notified.

103) Broken or cracked lenses of searchlight type signals shall be replaced as soon as practicable. Note in the case of SA mechanisms the green lense is precracked. If the mechanism cover glass, lens or color discs are damaged, the signal shall be arranged to display it's most restrictive aspect by opening the control relay circuit. The mechanism shall be replaced as soon as practicable. If the signal's most restrictive aspect is not plainly distinguishable, or the hood is not in place, the condition shall be promptly corrected, or the light shall be extinguished and Dispatcher or Operator notified.

104) Deleted

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., shall be kept tight and in good condition. The signal shall be maintained in an erect position.

106) Signals shall be aligned and focused to provide the greatest amount of preview for the engineer of approaching trains. Conditions that affect the preview of a signal shall be promptly corrected or reported to the Roadmaster and Dispatcher.

107) Prescribed incandescent bulbs or LED's shall be used and maintained at the specified voltage and replaced in accordance with manufacturer's instructions. 18 Watt and 25 Watt bulbs should not be used on Grade Crossing flashers and gate lights.

112) Where spread light type lenses or deflecting prisms are used, they shall 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 lenses, deflecting prism or phankill arrangement, except where phankills are used in color light signals; they are not required in the red unit. When necessary to replace such lenses, replacements shall be of the same kind.

113) Frequent inspection shall be made to avoid materials, snow, other surrounding lights, etc., from interfering with the preview of wayside signals. Tree limbs and foliage obstructing view of signals should be kept properly trimmed. Any evidence of construction that may eventually obstruct the view shall be promptly reported.

114) Signals shall be painted at a minimum every three years. Discolored backgrounds and hoods should be painted immediately. Adjusting bolts and door fasteners shall be lubricated to prevent rusting. Doors shall be gasketed and weather tight to prevent foreign material from entering the apparatus. Where screened air vents are provided, they shall be maintained so as to provide air circulation. Wire openings in signal units and masts shall be sealed to

prevent entrance of rodents, insects, etc.

115) Socket surfaces shall be kept clean and bright. Lamps shall be pressed into the socket far enough to be turned clockwise to the end of the slot so that the contact spring may force the lamp into proper position. Lamp receptacles may be changed or reset only when proper provisions are available for refocusing.

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

117) Searchlight mechanisms shall be maintained in accordance with manufacturer's instructions. Mechanisms should never be opened in the field, defective mechanisms shall be replaced promptly, and emergency mechanisms kept ready for immediate use.

118) To secure an electrical signal so as to display its most restrictive aspect, control wires shall be disconnected from the control relays and, in addition, if the signal is of the relay or mechanism type, either the positive or negative operating wires shall be disconnected from the relay or mechanism. It may be prudent to pull the grade crossing normal plugs located in the affected block out as an interim emergency measure to put signals to red but this should not be used as a substitute for securing signals. In a microprocessor based interlocking it is acceptable to de-energize "V-STOP" relays.

119) Automatic Signals shall be equipped with number plates showing digits for the mile post to the nearest even tenth of a mile for inbound governing signals and to the nearest odd tenth of a mile for outbound governing signals. Controlled Signals shall be numbered only on panel diagrams and on plans by digits and letter indicating track number and direction such as 2E, 2W, where practicable.

SECTION 5 TRACK CIRCUITS

150) For new work or rail renewals in track circuit territory, insulating rail joints shall be located as follows:

a. Wherever track circuits adjoin, insulated joints shall be located as nearly opposite one another as Track Department Standards will allow, but must not be staggered more than 56 inches under any circumstances.

b. To provide effectively for route locking, insulating joints shall be located opposite the dwarf signal as closely as possible. At other signals, insulated joints shall be placed not less than 5 feet or more than 13 feet in advance of the signal. At locations where opposing high signals are provided for traffic in either direction, insulated joints shall be located as nearly as possible midway between the two opposing signals, but not more than 13 feet from any interlocking home signal.

c. Insulated rail joints may be staggered in excess of 56 inches only at the end of a track circuit where there is no adjoining track circuit and no fixed signal.

d. Insulating rail joints in crossover and turnouts shall be located in accordance with Standard Signal Plans.

151) When questionable shunting conditions exist:

a. <u>In Interlocking Limits</u>:

When the head of rail in track circuit territory, within Interlockings, is covered with rust, sand, coal or other material which may interfere with the proper shunting of the track circuits, and which cannot be immediately cleared, the Maintainer must notify the Operator or Dispatcher by completing Form AMT 4-11 (Rusty Rail Notice), secure acknowledgement as provided on the Form, arrange to conspicuously <u>post the original copy at the control office and the local control panel</u> and distribute the remaining acknowledged copies as specified on the form.

The Maintainer must ensure that Dispatchers apply approved blocking devices to the affected apparatus. No alteration is permitted on the effective AMT 4-11 Form. A new AMT 4-11 shall be prepared for subsequent changes in rusted rail conditions as required, and handled in accordance with instructions.

NOTE: In CETC and CROCC territory, maintainer shall secure acknowledgement of rusty rail notice through the Trouble Desk.

Maintainer should retain a copy of all rusty rail notices in his territory and should review the same quarterly to ensure they are still required and in effect.

b. <u>Outside Interlockings, NORAC Rule 251, 261, 562 & Grade Crossing circuits</u>:

Where questionable shunting conditions exist in NORAC Rule 251, 261 or 562 territory outside interlockings or at grade crossings, the Maintainer must notify the Dispatcher and the Roadmaster immediately and arrange for the safe movement of trains by Form D protection. This may involve manually providing warning with properly equipped flaggers and the operation of manual control devices.

The signal system or grade crossing must not be restored to normal service 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 shall be met if the Maintainer, after the track is ready for service and after assuring that the block is clear, connects an ammeter in series with the track relay and carefully observes its performance when trains are

running through the block. The control wire should be held on the relay binding post or be prepared to open the test terminal, so that the relay can be quickly opened on the passage of a train should rust or foreign matter on rail prevent the relay from operating properly.

The relay shall be observed a sufficient number of times to positively ensure that it opens properly and remains open while the train is passing through the block.

<u>Note:</u> When current in excess of 25% of drop away value is observed under train traffic, the relay should be observed until this value is reduced. Under no circumstances should the track relay be restored to normal service if the residual current through the relay exceeds 75% of the drop away value of the relay while a train is occupying circuit.

152) 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, or frogs are removed within limits of the approach circuits at highway crossings, the Maintainer must take action to prevent unnecessary operation of such devices and take measures to provide for safe movement of highway traffic.

Where turnouts are being constructed or renewed in signaled main track, the signal governing movements over the turnout must display its most restrictive aspect until the main track guard rail is correctly placed and spiked, all switch plates on the turnout side are fully spiked in the correct position, the main track switch rail is spiked against its stock rail, and the free end of the stock rail is fastened to prevent movement. Upon completion of the above work, the signal system can be restored to normal operation.

153) Track circuits shall be adjusted and maintained in accordance with MBTA C&S 1 instructions (or appropriate manufacturer's instructions for audio frequency overlay circuits and / or proximity type detectors) as applicable. Track circuits should be checked in both wet and dry ballast conditions to ensure reliability and proper shunting sensitivity.

A check must be made of relay current and cab signal axle current (in cab signal territory) when tracks are raised, cleaned, or welded rail is installed, to prevent over energized condition, loss of shunting sensitivity and ensure broken rail protection.

154) 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.

155) When making rail or frog renewals, before rail is disconnected, a return path for traction current shall be provided by using a temporary shunt bond across the track from rail to rail on each side of the rail section to be removed, making sure that any insulated rail joints between the temporary shunts are bonded around to ensure a traction current path between the cross-track shunts through the remaining rail.

Connections for electric traction return current shall be in accordance with approved negative return plans.

When one side of an impedance bond is disconnected from rail, the insulated joint involved shall be bonded around to provide for a return path. When neutral leads of impedance bonds are removed, ***both*** insulated joints shall be bonded around to provide for a return path. In cab signal territory, a shunt must first be applied across the track from rail to rail to ensure no cab signal energy or track circuit energy is improperly passed through the location. This shunt must be applied ***before*** the insulated joint or joints are bonded around.

If this condition is to exist for an extended period, the feed of the adjacent track circuits

must be disconnected.

In all cases, temporary bonds shall be of sufficient capacity to maintain an adequate return path in the territory involved and they shall be removed as soon as they are no longer needed.

156) a. When cars are stored on a track protected by automatic block signals, the Operator or Dispatcher handling the movement must notify the Maintainer promptly advising of the limits of the track on which traffic will be suspended as a result of the stored cars. When cars have been stored for 24 hours, the Maintainer will on normal tour of duty disconnect the wires to track at both the relay and feed ends of each track circuit within the limits of the stored cars.

b. When the cars have been removed, the Maintainer must assure himself that the track circuits properly shunt and that signals function as intended, before restoring normal operation.

157) a. When cars are stored within the limits of an interlocking, the Operator or Dispatcher will secure the affected switches and signals with approved blocking devices The Operator or Dispatcher must notify the Maintainer, promptly advising of the limits of the track on which traffic will be suspended because of the stored cars. When cars have been stored for 24 hours, the Maintainer will on normal tour of duty disconnect the track wires at both relay and feed ends of each track circuit within the limits of the stored cars.

b. After cars have been removed, the Maintainer, prior to removing blocking devices must arrange for sufficient movement over the track circuit section to ensure proper shunting of the circuits. When both the Maintainer and Operator or Dispatcher has been assured that normal conditions have been restored, blocking devices may be removed. If normal conditions cannot be restored, Maintainer must comply with rusty rail instructions, Rule 151.

158) When stored cars will affect the circuits for highway crossing devices, approach locking, annunciators, etc., the Maintainer must take all necessary precautions to ensure safe operations and to safeguard the highway crossing affected. When the cars are removed, the Maintainer must restore circuits to normal operation and protect crossing until assured the crossing devices are working as intended.

159) 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 shall be secured by blocking devices until the movement is completed, to prevent improper operation that could result from rusty wheels failing to shunt track circuits.

160) Bonding, including track circuit connections, fouling wires, and cross bonding shall be applied and maintained in condition to assure minimum resistance. Where bonds cross under rails of opposite polarity, they should be secured from movement caused 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 applied 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. Fouling wires shall be installed and maintained so as to remain visible and clear of ballast, properly secured, and with adequate clearance under running rails or opposite polarity.

161) All track leads shall be paired and twisted with not less than one twist per foot. Track wire pairs with the same overlay frequency should be arranged to provide optimum separation

both in the ground and in the instrument case.

162) Track wires used for each end of each track circuit and cab signal feed shall be installed in the SAME twisted pair to avoid excessive voltage drop or improper energization through inductive coupling. Splitting a twisted pair to accommodate two different track circuits is strictly prohibited. Track wires in cab signal territory should be paired and arranged so as not to provide a foreign or stray field to affect a cab signal pick up coil. Series loop carrying cab signal energy through crossovers shall be located adjacent to proper rail as shown on Standard Plans. Track wires shall be installed and maintained in such a manner as to protect them from mechanical injury.

163) Audio-frequency track transmitters and receivers, or equivalent systems of like frequencies, shall be separated by the length of the case, or be in separate housings. Like frequencies on the same track should be separated, preferably by two sets of insulated joints, but in all cases by at least one set. On the same track, a receiver of less than 8 kHz must be separated from unrelated transmitters of the same frequency by a distance of at least 4000’ or by two sets of insulated joints.

Roadmaster shall be notified when frequencies are changed during maintenance or troubleshooting. All applicable tests including verification of adjacent frequencies should be made when replacing audio-frequency devices.

As a final check, where AFTAC is to be replaced and after verification that no like frequencies exist on the section of track, the receiver potentiometer should be turned fully clockwise for maximum output. The transmitter circuit boards should then be removed and relay drive at the receiver checked to verify no output is received. AFTAC receiver should then be adjusted according the manufacturer's instructions before being put in service.

164) Pipe lines under rail should be installed and maintained so as to provide at least once inch clearance under base of rail which forms part of a track circuit. Ballast shall be kept clear of signal pipe line to prevent mechanical interference with the free movement of pipe line and possible freezing of pipe line in the inter-tie space during winter weather (where welded rail is installed, care must be exercised to avoid skeletonizing the ballast support for ties).

165) When electric arc welding is to be performed on rails in track circuited territory or where arc welding is to be used in the vicinity of track where welding currents may enter the rails, signals shall be protected against improper operation.

Cable leads from each welding generator, where used in vicinity of track structure, must be laid in pairs close together to prevent interference with track circuits through induction. Both cables (electrode and ground) shall be completely and properly insulated throughout their length. Ground clamps employed for welding track structure must have full copper face for bearing against the web or base of rail to insure full and proper contact. The ground clamp must be applied to the rail being welded as reasonably close to the work as possible. It may be necessary to apply heavy duty shunts across the work area to short out stray welding currents and prevent damage to signal equipment.

SECTION 6 CABLES

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

202) Wires and cables shall be without splices as far as practicable. Splices, where necessary, shall be in accordance with approved manufacturer's instructions and when possible using a manufacturer developed splicing kit for the specific type of cable to which they are to be applied. Splices, when possible, should only be made in manholes, junction boxes, or at potheads. Direct burial splices must utilize an approved splice kit.

If vital working wires in a cable are severed, necessitating splices in the cable, the following will apply:

a. Cable conductors affected are to be opened at both ends of their termination points within adjacent housings. . Care should be taken to verify that tags match the placement of the wires before they are removed from terminals.

b. Individual conductors are to be carefully identified and each is to be properly spliced in accordance with the approved manufacturer's instructions to ensure full restoration of the insulation on each conductor.

c. Prior to restoring affected vital signal circuits to service, the entire cable shall be checked for ground and cross-meggered in accordance with C&S 1, Test 2, and each conductor properly identified at each end of the terminal boards. Each conductor is to be grounded three (3) times, while the Megger operator watches for the appropriate reaction on his megger, to ensure that the circuit tag nomenclature and the conductor number at the terminal board on each side of the splice are in full agreement.

d. If two or more vital working wires have been severed and disarranged, it shall be necessary to perform circuit breakdown test by opening the contacts on the vital relay associated with the circuit and observing that the appropriate controlled relay opens according to the approved circuit plans. This should be done for each affected conductor as its test links are being closed and prior to restoring the circuit to full service.

e. As soon as practicable, following full restoration of service, each splice shall be properly protected by an approved splice kit.

203) Cable conductors shall be numbered from core outward. When making splices, conductor number one shall be joined to conductor number one, etc. When reading cables, face the conductors at each end. Conductors at central instrument house end shall be read clockwise and conductors at function end, counterclockwise.

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

205) Wires or cables entering interlocking buildings, instrument houses, or instrument cases shall be connected to test 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 employed to connect the cable conductors to the local wiring. Random terminations are prohibited.

206) Not more than two (2) wires shall be installed on an AAR terminal post.

207) Jam nuts shall be used on threaded binding posts and shall be kept TIGHT. Care shall be used to avoid undue strain or damage to threads on binding posts. A full complement of nuts and washers shall be maintained on all terminals.

208) All crimped and solder less type terminals shall be checked to ensure that insulation has been properly removed and that the terminal has been properly crimped on the wire. Other terminals provided or recommended by the apparatus manufacturer shall be checked for tightness and proper installation.

209) Wire conduits or chase-ways shall be installed and maintained to prevent mechanical injury to the insulated wires and cables. Vacant spaces in wire openings of instrument cases, etc., shall be packed tightly with approved sealing material. Wire and cable openings through floors, and other wire ways which could act as a flue to spread any fire shall be sealed with an approved flame retardant sealing material.

210) Exposed buried wires and cables entering bottom of cases, housings and other structures shall avoid sharp turns and be protected from mechanical injury and fire. Pipes, conduits, and channels shall be secured to prevent slipping or settling.

211) Cable and wire installed within the track structure where possible and practical shall be at a minimum depth of 30 inches below the bottom of the tie and within conduit. To deviate from this, approval of the ACE C&S is required. All excavation within the track structure shall be filled in prior to stoppage of work. Backfill must consist of a bed sand or fine soil above and below cable, rock-free soil, topped off with railroad approved ballast and tightly compacted through careful hand tamping throughout the crib and extending one foot beyond end of tie. The ballast contours shall be maintained throughout the excavation process and include the ballast adjacent or parallel to track structure.

212) In all cases duct lines and underground wires and cables shall be identified and located on signal layout plans both at the location and the copy maintained at the Signal Design Office. Where practical and available cable markers shall be carefully placed above the cable installation taking care not to have the markers damage the cable(s). Where cable is plowed, a marker tape is to be plowed in six inches above the cable.

213) Conduits and ducts between manholes or similar openings underground and junction boxes, instrument case or similar housing above ground, shall contain additional pull strings for future use and be sealed with an approved sealing compound.

214) Broken insulators supporting open wire signal circuits on pole line shall be replaced.

215) Guy wires shall be inspected annually and adjusted for tension when necessary, preferably in the fall of the year.

216) When poles are replaced, wires shall be transferred to the new poles promptly and old poles removed and disposed of.

217) All linemen shall inspect the condition of poles and line, the location of power wires on the line and the location of wire line crossings before ascending the pole. Such inspection for potential hazards shall include a minimum of four pole lengths each side of pole to be climbed, striking the pole with a hammer to "sound" the pole and any other precautionary steps are required to carry out the work safely.

218) After ascending the pole, a second inspection shall be made from this height advantage before work is started.

219) Ground men shall not handle wires that are down until inspections are made and precautions have been taken to ensure that work may be done safely.

220) Such precautionary measures may include:

a. Shutting off railroad power

b. Installing protective barriers

c. Requesting power company to shut off commercial power or to install protective barriers

d. Using electrical protective gloves.

221) When working as a member of a group, each employee will observe and protect against hazards for themselves and other members of the group.

223) C&S employees will be responsible for installing only authorized cable and wire. When in doubt as to the applicability of any particular wire or cable make-up, the Roadmaster shall be contacted immediately and the material not used until certain that it is the proper material.

SECTION 7 CHANGES AND TESTS

250) Alterations must not be made to any apparatus or circuits without proper authority. Plans for such alterations shall be obtained from the Office of the ACE C&S or Senior Engineer C&S Design. Minor or temporary alterations can be authorized by telephone and shall comply fully with Rule 26.

251) All alterations shall be made under the supervision of a qualified, designated, competent employee who is personally responsible for work under Rules 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 person in charge shall be responsible for the accuracy of local circuit plans 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, shall be plainly marked.

252) 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.

253) Any necessary relocation of apparatus and wiring in service, either permanent or temporary, shall be made under the personal direction of the employee in charge, and all circuits interfered with in any way shall be thoroughly tested immediately after relocation and before apparatus and/or circuits are place back into service.

254) New apparatus shall be thoroughly tested in accordance with the MBTA C&S 1 and 2 and be placed in a manner where new wiring will not disturb as in-service equipment.

255) Connections to wiring in service shall be performed under the direct supervision of the employee in charge. All wiring placed into existing apparatus and circuits shall be tested before entering service.

256) The employee 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 diagrams or circuit plans conditions 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 shall be marked with green tags. Wires which are to be removed at cut-over shall be marked with red tags. Wires, which, for any particular reason, cannot be hooked up without special arrangement, shall be marked with yellow tags. Wires bearing yellow tags shall be connected only by the employee in charge or under their specific instructions, which shall definitely state that "yellow tag wires" are to be connected. On completion of changes, all colored tags must be removed. Wires taken out of service shall be removed and ends cut back to a safe position until they can be completely removed.

257) Before final cut-over, all circuits to be changed must be thoroughly tested as far as practical. Final arrangement shall be tested in its entirety by a qualified, designated, competent employee other than the employee in charge of performing the wiring work.

258) Deleted

259) The qualified, designated competent employee engaged in making or testing circuit changes must have a full understanding with the Operator or Dispatcher as to any interference that could occur to the in-service signal system. Prior to the operation or the positioning of switches or signals, permission must be obtained from the Operator or Dispatcher and performed in accordance with Rule 407. The employee in charge of changes must cooperate with the Maintainer and keep him informed at all times as to the condition of the the signal system. All signal testing and circuit changes shall be performed in accordance with all of the applicable provisions of MBTA C&S 1 and MBTA C&S 2.

260) To provide a check against misunderstanding when the qualified, designated, competent employee in charge directs another to close or open wire connections to wiring or apparatus in service, it must be stated specifically what is required, using the relay or device name and contact or terminal number or other definite description, and must receive confirmation from the person at the wire by that person reading the wire number back as a check. The employee in charge must indicate on the circuit plan or the wiring diagram the connection that is to be closed or opened.

If the open circuit is protected by a yellow tag, the employee 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 yellow tags unless specifically directed, and after carrying out the order must advise in detail, using wire numbers or other definite description.

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

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

263) Alterations or changes to microprocessor interlocking must not be made without proper authority. All changes to microprocessor Interlockings shall be made in accordance with the KCS Software Management Control Plan (SMCP, see Appendix 5) under the direction of the Senior Engineer Design and all testing shall be done in accordance with this policy.

Testing procedures and E Prom verification must follow the SMCP. Please refer to C&S 1 Test 23.

SECTION 8 RELAYS, CIRCUIT CONTROLLERS AND USE OF JUMPERS

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

301) The bridging of contacts on relays, or any circuit controlling device, or energizing relays or devices directly from any source which will in any way impair the protection of such circuit controlling device shall be done in accordance with the following instructions:

NOTE: Use of Jumper Enable Terminals at Microprocessor Interlockings constitutes the use of jumpers within the meaning of this section and requires the same procedures.

a. Jumpers will not be applied until specifically authorized by the ACE C&S, Senior Engineer C&S, Roadmaster C&S or C&S Duty Manager with a full and complete understanding as to the application of the jumpers by all concerned parties. Also, protection shall be afforded by the Dispatcher to protect circuitry that is disabled as a result of applying the jumper. In addition, protection also shall be afforded in the field, if possible. Before the ACE C&S Senior Engineer C&S, Roadmaster C&S or C&S Duty Manager authorizes the use of jumpers, every attempt to correct the situation by other means should be made. Generally, jumpers should not be used in conjunction with ordinary maintenance or programmed work (unless if necessary to comply with # 152), and it should NOT be necessary to pick a track relay with jumpers under any circumstance. The application of jumpers should be the last resort.

b. After jumper permission is granted, a log of the permission shall be made at the respective Trouble Desk on the Trouble Desk database.

c. The sequence for applying a jumper will be in the following order:

1. Permission shall be obtained from the ACE C&S, Senior Engineer C&S or Roadmaster C&S. The person receiving the jumper permission will inform the Dispatcher or Operator as to what is "jumpered" out and what portion of the signal or grade crossing system is inoperative. **The C&S employee authorized to apply the jumpers shall be held personally responsible for their proper application and removal.**
2. **(Deleted)**
3. The person receiving the jumper permission will inform the Trouble Desk that jumper permission has been granted and describe the time, what is jumped, who authorized the jumper, who is applying the jumper, what protection is provided and the name of the dispatcher or operator whom was notified. The Trouble Desk will log this and all other pertinent information on the C&S Trouble Desk database.
4. The ACE C&S, Senior Engineer C&S, or Roadmaster C&S will follow up with the Trouble Desk to ensure that the jumper permission that was granted is correct as authorized.
5. The ACE C&S, Senior Engineer C&S or Roadmaster C&S will check with the Trouble Desk to determine the status of all jumper permission granted periodically during the day to determine if the jumpers are still in service or removed.
6. The Trouble Desk will provide ADE C&S, Senior Engineer C&S and Roadmasters

with a list of all jumper permissions that were issued for the prior 24 hours and identify those still in service each morning on their respective territories.

7. The ACE C&S, Senior Engineer C&S or Roadmaster C&S will verify each morning that the jumper permission is correct for their respective territory.

d. The sequence for removing a jumper will be in the following order:

1. The person who was authorized to apply the jumper is the only one that can remove the jumper, however, if unavailable the ACE C&S, Senior Engineer C&S or Roadmaster C&S who was involved granting the jumper permission may authorize its removal.
2. Before a jumper is removed a full understanding must be had with the Dispatcher or Operator as to when the jumper can be removed safely.
3. After permission is granted by the dispatcher or operator to remove the jumper, the circuitry involved shall be checked for integrity and proper operation as intended by the approved circuit plan.
4. Once jumper is removed, the dispatcher or operator and the Trouble Desk shall be notified immediately by the person authorized that the jumper has been removed and the circuitry is back to normal as per the circuit plan.
5. The Trouble Desk will then enter in the Trouble Desk database that the jumper is removed, by whom, date and time, circuitry is or is not back to normal per circuit plan, dispatcher or operator has been informed and all other pertinent information.

302) **The guiding principle at all times must be that any protection temporarily defeated by the jumper shall be provided by some other means until the removal of all jumpers is assured and the original protection is restored.**

The picking of Lock Circuits or taking apparatus "off Time Locking" or the use of "Jumper Enable" features at Solid State Interlocking shall be in strict compliance with the procedures above. (See also #409)

303) Jumpers shall be a minimum of eight (8) feet in length, of flexible wire not smaller than No. 16 AWG. and shall be visible and not coiled when applied. An approved tag (C&S AMT 301, C&S Authorized Jumper Tag) shall be affixed to all jumpers that are applied, that will remain in place in excess of one-hour and have the following information:

a. Name of person who received authorization and applied the jumper.
b. What circuitry is disabled?
c. Reason for jumper being applied.
d. Authorized by
e. Date and time jumper was applied.
f. Signature of person applying jumper.
g. Date and time jumper was removed.
h. Signature of person removing jumper.

Tags shall be retained by the employee who removed the jumpers for a period of 30 days.

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

a. **Where jumpers are to be applied in lieu of switch point detection, switch points must be blocked and spiked or clamped and the power to the switch machine shall be removed. Points must be inspected <u>prior to each and every train movement</u> over the affected switch. Dispatcher shall be advised that jumpers have been applied and that signals should not be cleared unless authorized by the employee who has applied the jumpers.**

b. The following procedure shall be strictly adhered to in the application of jumpers when supporting Sperry Rail or other Track Department testing.

Signal Inspector will contact the Roadmaster or C&S duty officer and obtain jumper permission for the affected crossings for that day's work. The Signal Inspector will hold a job briefing with all employees detailing the procedure as outlined below.

Track Foreman in charge of obtaining permits will be advised that jumpers will need to be applied. Where jumpers are to be applied, a FORM D, LINE 4 will be taken by the Track Foreman and then the Signal Inspector will take crossings within the limits out of service for the track affected. The Track Foreman, Train Dispatcher and Trouble Desk will be notified that the crossings are out of service in accordance with NORAC Special Instruction 133-S6 for the affected track.

If jumpers are not to be applied, Track Foreman will be permitted to take a FORM D, LINE-2.

<u>Under no circumstances will jumpers be applied with a NORAC Form D Line 2 in effect.</u>

After Sperry work begins Maintainer will (if it is necessary to apply jumpers) request jumper authority from Inspector. Inspector will instruct that Maintainer to remove plug from Emergency Control "Normal" position. Jumpers may now be applied to cut out the crossing on the Track affected while Maintainer remains at the crossing. When Sperry Car (or other Track vehicle) passes Maintainer will remove jumper. <u>After</u> this is done he will then restore emergency control plug to normal position. Crossing will then be shunt tested and crossing book signed. Maintainer will then advise Inspector that jumpers have been removed and crossing is returned to normal. **<u>Under no circumstances will jumpers be applied unless "NORMAL" plug is removed for this work.</u>**

Inspector will make notation in the sheet provided what crossings had jumpers applied, who applied them and most importantly what time they were removed. Inspector will then advise the Track Foreman, Dispatcher and Trouble Desk when all jumpers are removed in accordance with Special Instruction 133-S6.

The Inspectors' role is to supervise this procedure and under normal circumstances he should not be engaged in cutting out crossings himself.

NOTE: The intention of these instructions is twofold: 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.

Individual manning the C&S Trouble Desk should be qualified in C&S 1 and 2.

305) 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 strictly prohibited.

306) The seals on relays and other similar apparatus must in no case be broken except by an authorized person. Apparatus with broken seals shall be removed from service immediately unless broken by an authorized employee and are re-sealed prior to re-entering service. Relays or similar apparatus removed from service due to defect must have a red tag attached stating defect, if known, and marked "not fit for service." They must not be used again until a white tag is attached by Test person man or Inspector stating, "O.K. for service."

307) Where contacts are visible, contact openings and alignments must be observed, and, if found more or less than normal or otherwise defective, apparatus must be replaced.

308) 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. DC Polar Relay:

1. With polar armature operating in a horizontal plane - contact must rotate counterclockwise, viewed from above.

2. With polar armature operating in a vertical plane - contacts must rotate clock-wise, viewed from the front.

309) All circuit controllers shall 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. Air vents shall be kept clean and open at all times.

310) When work is being performed on polarized circuits, only one wire shall be disconnected at a time. Wires and posts shall be clearly marked to avoid any possibility of reversing the polarity of the circuit.

After wires are restored, necessary checks shall be made immediately to determine that all affected equipment is functioning as intended. These checks shall include both positions of all polar relays affected AND the signal aspects involved with each position.

311) Plug in relays and bases must have the proper index plates and pins in accordance with the approved circuit plans.

Items 312 – 349 are reserved for future use

SECTION 9 MOVEABLE BRIDGES

350) Rail indicating circuit controller shall not be bypassed.

351) Circuit Controllers operated by rail indicating the position of devices on the moveable span shall be kept adjusted so that the circuit will not be completed unless the track rails on the moveable span are within 3/8-inch of the correct surface and alignment with the rail seating device on the bridge abutment or fixed span, in accordance with MBTA C&S 1, Test 14.

352) Proximity switches used for rail detection shall be kept clean and free of debris or obstructions.

SECTION 10 INTERLOCKINGS, TRAFFIC CONTROL SYSTEMS AND SWITCHES

400) Communication and Signal Department employees must not operate controls of an interlocking or remotely controlled signal facility except for test, RWP and inspection purposes or in an emergency, and then only after a definite understanding is had with the Operator or Dispatcher having jurisdiction over the interlocking or control station. Maintainers are to be qualified to take over local control when required.

a. When interlocking signals cannot be displayed remotely and the local control panel is functioning as intended, it may be used by the Maintainer (or an extra operator in extended emergencies) to control the interlocking under the direction of the Operator or Dispatcher having jurisdiction over the interlocking or control station. If there is any question as to the proper functioning of the local control panel, its indications should be verified by comparison with corresponding vital relays in the central instrument house. If operating requirements can be met by fleeting signals locally, then that should be done with the proper understanding of the Operator or Dispatcher having jurisdiction over the interlocking or control station.

b. When interlocking signals cannot be displayed remotely or locally, and the position of one or more switches in the route cannot be positively determined due to loss of switch indication on local control panel and vital switch correspondence relays in central instrument house, train movements shall be protected by placing the switches involved in the position required by the Operator and securing these switches in accordance with Rule 407. Advise the Operator at once as to which switches have been "spiked and wedged" and keep the Operator informed of any subsequent changes.

c. At a remote controlled interlocking when any code system interface relays or cards are to be changed out, the following will govern:

1. The Interlocking shall be placed in local control with the concurrence of the Operator or Dispatcher having jurisdiction over the interlocking or control station.. If the interlocking can be fully controlled from the local control panel and trains can be moved on proper signal indications, then the code system interface relays or cards may be changed out. Each function affected shall be fully checked operationally, including observation of vital relays, to ensure proper functioning before full restoration to remote control is permitted.

2. If takeover to local control cannot be effected, or if signals cannot be displayed by local control, then remote/local control must be left in "local" position. Train movements within the interlocking must not be permitted while interface cards or relays are being changed or interface circuits are in any way disarranged, unless ALL switches in the interlocking are secured in accordance with Rule 407.

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, the obstruction test in accordance with C&S 1, Test 13, shall be made before switch is restored to normal service.

402) The locking edges of the openings in lock rods shall be square. Plungers and locking dogs shall be full size and the corners square at the locking end. Rod shall be clear of locking dog or plunger (when unlocked) and must move more freely when operated without binding in

its guide. The small openings in lock rods must not exceed the width of the rectangular locking dog or plunger by more than ⅜ of an inch. Bolts, nuts and jam nuts must be in place and in good condition.

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

404) Holes in lock rod shall have square edges and shall not be more than 1/8 inch larger than the round plunger.

405) When, for the purpose of maintenance or repair, or when notified a unit is inoperative or disconnected, the Maintainer must determine that approved blocking devices have been applied to the controlling lever and levers. When necessary to apply Blocking Devices on levers of electro-mechanical machines, they shall be applied to both large and small levers.

406) When necessary to disconnect a switch, moveable point frog or derail (hereinafter called switch) from its operating mechanism or to disconnect No. 1 switch rod, the following shall be done as part of providing complete protection for trains:

a. The closed point shall 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 39 and 45 foot switches at the midpoint. Where possible, the spikes must pass through the tie plates. Longer switch points with additional switch machines shall be spiked at each switch machine. On concrete ties or where a spike cannot be installed, an approved switch clamp shall be installed and locked into place using an approved signal lock.

b. A standard wooden wedge, shall be driven between the open point and the stock or knuckle rail and (if switch is out of service for extended periods) 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 shall be secured in place by a cotter pin and split key below the bottom 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 Rules 406(a) and (b). If the open point is removed, trailing movement may be made after the closed point has been secured in accordance with Rule 406(a). For facing movements, end of lead rail shall 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 a switch is in automatic block signal territory, or is connected with a distant switch signal, the work shall be done under the direction of the Track Foreman in cooperation with the Maintainer.

e. If the switch is in an interlocking, the following must also be done:

1. The locking dog or plunger must be inserted through lock rod, if possible.

2. Deleted.

3. The power for power-operated switches shall be removed by opening the switch power either on the terminal board or by removing the fuse disconnects.

4. Power-operated switches shall be kept spiked and wedged until the power is

again turned on so that an accidental change in the position of controlling apparatus or connections cannot cause the switch to go to the wrong position.

f. When necessary to disconnect switch, derail, or other unit, it should be done nearest the unit.

407) When necessary to disconnect or impair function of locks, circuits or other safeguards in an interlocking, all switches affected shall be safely secured as follows before any train or engine is permitted to pass over them:

a. The closed point shall be held against the stock or knuckle rail by a spike in the head tie, and on 39 and 45 ft. switches at the mid-point. Where possible, the spike must pass through the tie plate. Longer switch points with additional switch machines shall be spiked at each switch machine. On concrete ties where a spike cannot be installed, an approved switch clamp shall be installed and locked into place using an approved signal lock.

b. A standard wooden wedge shall be driven between the open point and the stock or knuckle rail. In the case of power operated machines, power shall be removed by removing the fuse disconnects or opening the motor control wires on the Main Terminal Board (MTB).

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

408)

Deleted

409) Lock relays in all relay interlockings shall not be energized by a jumper, except in case of emergency or when necessary on account of repairs, and then only upon authority of the Roadmaster C&S, Senior Engineer C&S or ACE C&S as per Rule 301**. Before any work is done, the Local Control of the Interlocking shall be taken by the Maintainer who obtains the jumper permission.** Whenever an electric lock circuit is momentarily energized, notation shall be made by the Train Dispatcher on the train sheet. The Maintainer must make a detailed report on the Maintainers Daily report Form. After authority has been received to momentarily energize a lock circuit, the following precautions shall be taken:

Where provided, jumper enable circuits, used for emergency release of locking in microprocessor Interlockings, shall be used in strict compliance with existing jumper rules 301 thru 304 and rule 409.

Jumper enable circuits cannot be used unless the Interlocking is in Local Control mode with Dispatcher permission. Detailed procedures on the jumper enable operation are posted at each location.

a. Signal Indication Locking

If a route in an all-relay interlocking cannot be released, the lock relay must not be energized manually nor the RGPR (RPR) or ASLR (ASR) momentarily energized until the Maintainer knows that all signals directly controlled are in "Stop" position and all signal lighting relays and/ or search light signal mechanisms controlling the RGPR are in fully de-energized (or Red) position.

If the Maintainer or Operator knows that the home signals controlling the affected lock or relay are in "Stop" position, an arrangement may be made by the Dispatcher to positively notify all trains governed by these home signals to approach them prepared

to stop until examination has been made. The lock relay may then be energized momentarily to restore the desired route.

Examination must be made as soon as possible to determine whether the lock or relay failed to release on account of the signal failing at more favorable than its normal position or because of an open indication circuit.

b. Switch Detector and Route Locking

Switch locking relays must not be released until it is known that the signal displays "Stop Signal" (NORAC Rule 292) and that a train or engine has not passed the signal and that the route is not occupied or fouled by a train, engine or car. **The picking of track relays or repeaters to release switch detector locking is strictly forbidden.** In all-relay interlockings the proper lock relay shall be selected. A signal more favorable than Restricting (NORAC Rule 290) must not be displayed until the track has been inspected, unless the switch correspondence and track occupancy light show that route is properly lined and the track is clear.

In the event of an emergency the following procedure shall be strictly adhered to when releasing locking to line a route:

1. Call the Dispatcher and verify there are no trains moving within the interlocking.
2. Request permission to take Local control of the interlocking
3. Call the Roadmaster C&S, Senior Engineer C&S or ACE C&S and request jumper permission in accordance with C&S-2 #301 detailing the circuit that will need to be energized. Conduct a job briefing giving full details of proposed actions.
4. Check that all Red Repeaters (RPRS or RGPRS) are energized to ensure all signals are at stop.
5. If a track circuit is down, walk the track to ensure there are no broken rails
6. Notify the Dispatcher that jumpers will be used to move switches
7. Momentarily energize the appropriate lock relay or track repeater and use Local Control Panel to restore the desired route. Check that the switch indicates the desired position.
8. Remove the jumpers
9. Notify the Dispatcher that the jumpers have been removed and verify the switch position.
10. Restore the interlocking to Remote Control

c. Traffic Lever Lock or Traffic Relay Circuits

Traffic lever locks may be released manually or traffic relay circuits poled in opposite direction only after arrangements have been made with the Dispatcher to safeguard the movement of trains in the territory affected. Traffic relay circuit may be poled to correspond with direction of trains already moving in the block after it can be positively determined that no signal or authority has been given to any train, engine or car to enter the block in the opposite direction.

d. Electric Locks on Hand-Operated Switches

Electric locks on hand-operated switches may be released by hand after permission is obtained from the Dispatcher.

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

414) (Deleted)

415) (Future use)

416) Employees must not operate 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, shall be locked in normal position.

417) **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 operation**.

418) Deleted

419) Deleted

420) Deleted

421) Deleted

422) Deleted

423) Model 9 or T20 hand-operated switch machines along with a suitable electric lock shall be used in cab signal territory and electrified territory. Hand-thrown switches in signal territory other than the above shall be equipped with an approved Maintenance of Way switch stand and circuit controller.

SECTION 11 CAB SIGNAL SYSTEM

463) The test circuit or test loop for cab signals shall be maintained in good condition and current properly adjusted.

464) The test loop for cab signals shall not be installed in signaled territory unless authorized by the ACE C&S.

465) Insulated joints in cab signal territory shall be inspected in accordance with MBTA C&S 1, test 24F. In electrified territory, breakdown of a single joint will allow cab signal current to pass around the other joint through the impedance bond.

SECTION 12 HIGHWAY GRADE CROSSING WARNING DEVICES

500) During or immediately after a snow or sleet storm, when conditions warrant, checks shall be made of all Automatic Highway Warning Systems (AHWS) to determine that the Power is on and that all electric crossing gates are operating correctly. Care shall be taken to remove snow and/or ice that could be sufficient to interfere with proper operation of the gates..

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

b. Gate arm position shall 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 arm shall be checked in accordance with MBTA C&S 1, test 26A. Gate arm must be checked when in the raised position to avoid the possibility of arm being fouled by outside utilities like wires or cables as well as brush and tree limbs.

d. Lubricants, as specified by the Chief Engineer or in accordance with manufacturer's recommendation must be used.

502) When an AHWS or train approach warning device fails to properly indicate the approach of trains, the Dispatcher and police agency having jurisdiction shall be notified and alternative warning shall be provided promptly and maintained until necessary repairs are made in accordance with 49 CFR 234.105.

503) When there is an accident at a crossing equipped with automatic warning devices, manual warning must be provided as soon as possible. The Maintainer must make necessary observations and tests to determine if the warning devices were working properly, and report conditions to the Roadmaster and be governed by the Roadmaster's instructions. The Maintainer should, if possible, obtain the name and address of the person or persons injured, also the license number of the vehicle involved, and of as many witnesses as possible.

504) a. Accidents involving grade crossing activation failures shall be reported to the Federal Railway Administration for every impact between a train and an automobile, bus, truck, motorcycle, bicycle, farm vehicle, or pedestrian at a highway-rail grade crossing involving activation failure. Notification shall be provided by the ACE C&S to the FRA within 24 hours of occurrence, the FRA shall be notified via telephone (800-424-0201) by the ACE C&S or his designated representative. The report to the FRA will include the following:

1. Name of the railroad,
2. Name/ title/ telephone number of the individual making the report,
3. Time/ date/ location of the accident,
4. U.S. DOT - AAR Grade Crossing Identification Number,
5. Circumstances of the accident, including operating details of the grade crossing warning device,
6. Number of persons killed or injured, if any,
7. Maximum authorized train speed, and
8. Posted highway speed limit, if known.

b. This telephone report is not a substitute for other required written reports such as FRA Form F6180.83. Every telephone report shall be followed by a written report as required by Rule 505.

505) **All alleged "failure to activate" crossing incidents must be investigated thoroughly under the direction of a Roadmaster C&S or other C&S Manager,** and a written report shall be made by the Roadmaster C&S on FRA Form F6180.83 "HIGHWAY RAIL GRADE CROSSING WARNING SYSTEM FAILURE REPORT". The report shall be submitted to the ACE C&S within 24 hours of the failure. The ACE C&S will send the completed report FRA Form F6180, 83 (4/98) to the Chief Engineer within 5 days of occurrence if the report is valid.

Event recorders shall be downloaded as soon as possible for each alleged failure to activate and data analyzed to determine validity of report.

506) Reports of AHWS malfunctions must be promptly investigated to determine the nature of the malfunction. Until investigation is complete and repairs are made (if required), every effort will be made to warn highway users and railroad employees in accordance with 49 CFR 234.105, 234.106 and 234.107.

507) Crossing AHWS will be maintained to provide a warning time indicated on the highway circuit plans, however in no case will the warning time be less than 20 seconds at the maximum authorized speed or in the case of a gated crossing the gates shall be fully lowered five seconds prior to the arrival of a train.

508) Flashing light units must be maintained such that they are clearly visible by each approaching highway traffic lane as well as pedestrian way. Lenses shall be kept clean. Cracked or broken lenses shall be promptly replaced.

509) Lamp voltages shall be maintained at not less than 85 percent of the rated voltage for the lamp. For example, a 10 volt, 12 watt lamp shall be maintained at not less than 8.5 volts.

510) Highway traffic preemption circuits shall be tested each month and shall not be removed or disconnected without approval of the Chief Engineer. When possible, joint testing between the AHWS system and the highway traffic control system should be performed. If joint testing is not possible then the employee performing the monthly test shall observe a train movement through the crossing to determine that preemption circuit is working in accordance with the approved plans.

Traffic signal preemption is designed to allow the highway traffic system to turn Green allowing for a traffic queue to clear the tracks prior to the arrival of the train occupying the crossing. Any failure of this system shall be immediately reported to the train Dispatcher, local police authority, Roadmaster/Duty Manager and ACE C&S immediately.

Changes to the highway configuration, or temporary re-channeling of traffic due to construction that could affect preemption effectiveness should be reported to your Roadmaster / Manager immediately.

511) Loop detectors, where used, must be kept in good working order. Damaged loops shall be repaired immediately. Detection loops interfaced into the AHWS shall not be removed or disconnected unless approved by the Chief Engineer and circuit revisions issued by the signal design office.

512) When work is being performed on the track that will cause unnecessary activation of crossing signals they must be secured to prevent the unnecessary activation. This may be done with the emergency control plug override circuit if provided or by using a jumper to hold up the approach relay(s) on the appropriate track until the work is finished. If a jumper is used it shall be applied in accordance with the jumper rules (Rules 301 through 304) and

arrangements must be made to warn highway and/or pedestrian users of approaching train movements. In multi-track territory the use of jumpers or override circuits shall only apply to the track affected..

In the event of a crossing malfunction where plugging out the gates will cause major train delays, C&S Management may be directed to authorize the use of jumpers and to return emergency plugs to the normal position. In this scenario the Maintainer is to be directed to ensure Form D Line 12 is in effect and should be instructed to remain at the crossing while jumpers are applied.

NOTE: The troubleshooting of the original failure should only be performed by a separate maintainer or other qualified KCS employee.

a. Procedure:

1. Take affected crossing out of service with Dispatcher.
2. Notify Roadmaster, receive jumper permission and log in Trouble Desk
3. Apply battery to approach circuit to hold crossing clear. (Take least amount of protection out as possible as per C&S 2, #304)
4. Manually control crossing for trains. (Where one or more crossings are affected, NORAC and KCS Timetable and Special Instructions will govern Train movements over crossings at all times.

   Examples of locations where this might be necessary include, but are not limited to;

   - Mid to Stanley
   - Beverly Junction to Chesley
   - Chesley to Ipswich West
   - Knight to Steeves
   - Everett Junction to Brickyard
   - Willows to South Acton
   - Reading to Frye (CPF-FY)

513) All Tests and inspections shall be made in accordance with C&S 1, Test 26.

514) **At Grade Crossings where there is an event recorder in service (includes predictor recorder boards) all "clear on arrival" crossing failures are to be downloaded if a Technician or Specialist is on duty or as soon as practical.** If a cause for the failure can be determined it should be discussed with the responding Maintainer to assist with troubleshooting. Copy of the downloaded file should be sent to the Signal Roadmaster or Senior Engineer.

The Roadmaster should arrange for a download at the earliest opportunity to determine cause.

515) Grade crossing recorders equipped with alarms that report events to CROCC should be handled using these revised guidelines. When the Electronic Specialist on duty, receives an alarm, specifically related to a 'crossing failure', it shall be reported to the Train Dispatcher first and then the Trouble Desk immediately.

The following list of alarms are considered to be directly related to the proper operation of the grade

crossing and fall under the above directive.

1) Activation Starts

2) Activation Time

3) Current Low

4) Movement Time Down

5) Movement Time Up

6) Gate Control Delay

7) Warning Time

Any alarms generated, but not specifically related to a 'crossing failure' are to be reported to the Trouble Desk.

516) When it is necessary to adjust crossing predictors or motion devices, shunt tests must be made on both approaches to check that warning time and approach length match what is shown on crossing circuit plans, meet the requirements shown in Rule 507 for a train moving at maximum authorized speed.

SECTION 13 TRAIN INSPECTION DEVICES

525) Snow, ice or any obstruction shall be kept clear of detectors so as not to interfer with the proper functioning of the detecting devices.

526) Self-restoring dragging equipment detectors shall be inspected monthly and after derailed equipment has passed over them to ensure proper operation.

527) Self-restoring dragging equipment detectors shall be lubricated, cleaned and any loose parts made secure every three months.

528) Hot box detectors shall be maintained in correct gauge and alignment and kept free of snow, ice and other debris which could affect their operation. Specific tests in accordance with manufacturer's instructions and/ or C&S 1 to ensure proper operation shall be made.

529) Hot box detector tapes shall be observed as often as practicable and scanned for any indication of a malfunction of the hot box detector or telemetry equipment.

530) High load detectors and wheel impact detectors shall be maintained in accordance with the manufacturer’s instructions.

540) When performing an electrical test 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 a temporary telephone, it must be known that the use of telephone will not, in any way, affect the circuits.

Meters that are used when making electrical and electronic tests of switch and signal circuits shall be kept in good working order and shall be calibrated as recommended by manufacturer’s instructions or at least once every two years.

Meters that appear not to be accurate shall be compared with another known accurate meter before continuing its use.

541) Periodical tests of signaling and interlocking devices shall be made regularly. The frequency of tests specified in C&S 1 represents the maximum interval between tests. Local conditions may make more frequent tests advisable.

542) Other tests that may be designated from time to time shall be made in accordance with instructions that shall be issued in connection therewith.

SECTION 15 BATTERY CAPACITY FOR SIGNAL FUNCTIONS

549) The following battery sizes shall be used for the signal functions shown.

Exceptions to this standard may be granted by the Chief Engineer C&S to cover installations having unusual requirements.

Table 15-1. Battery Capacity Standards for Signal Functions

FUNCTION	CONDITIONS	MINIMUM STANDARD
Switch battery (where required)	Both H.V. machines	At least 80 AH
Central Instrument House		AS per circuit plan
Home Signal Locations and Automatic Block Signal Locations	Approach Lighted	160 AH
	Constantly Lighted	240 AH
Code System Battery	Office and Field Locations	240 AH
Gates and Flashers		240 AH
Flashers Only		240 AH
Overlay Transmitter Locations	Up to 2 transmitters	80 AH
	Over 2 transmitters	160 AH
Overlay Receivers-Island Circuits	For 2 receivers	80 AH
Overlay Receivers-Harmon Motion Detectors	For 1 track	80 AH
	For 2 or more tracks	160 AH
Motion Sensor or GCP		160 AH/unit
Track Cells	Conventional DC, coded track	120 AH

SECTION 16 BATTERIES IN FLOATING OR TRICKLE CHARGE SERVICE

NOTE:

Floating Charge - A continuous input of current to a storage battery.

Trickle Charge - A continuous input of current to a storage battery to compensate for internal losses only.

Batteries connected directly across rectifiers and load is under floating charge.

Batteries connected across rectifiers, but to the load only when alternating current power is off, are under trickle charge.

550) Containers must be kept clean, level, and as dry as practicable. Spillage must be removed to prevent corrosion and/ or leakage of current.

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

552) All connections shall be kept clean and tight. Exposed brass or copper battery connections shall be kept covered with a thin coating of Vaseline, No-ox-id or equivalent.

553) Battery housings and compartments must be kept clean and dry, and when batteries are located in a building, ventilation shall be provided. Where the inside is of wood or metal, it must be painted with acid resisting paint.

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

555) Hydrometers and syringes must be properly protected against breakage and against injurious effects on the apparatus from acid. A separate syringe shall be used for each type of battery.

556) Distilled water, or water approved for use in batteries, shall be kept in covered glass or plastic containers, which must not be used for other purposes.

557) 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, the solution shall be agitated by use of the syringes to prevent freezing. Spillage shall be removed to prevent corrosion and/ or leakage of current.

558) Meters shall be checked for accuracy if readings are questionable.

559) An exposed flame must not be allowed near a battery, as the gases being given off may explode. Care must be exercised in the use of tools near battery terminals to prevent striking an arc. To prevent drawing an arc when connecting or disconnecting cells, the load and charging circuits must be disconnected at a point away from the battery, preferably at the buss.

560) A battery card for each set of batteries shall be kept at each location. The battery voltage shall be recorded on the card along with the date tested. Voltage tests shall be done each time the location is visited or weekly at a minimum. (Refer to C&S 1, Test 18 for frequency)

561) Once each quarter a load test shall be performed on each set of batteries by disconnecting the battery charger and monitoring the battery voltage under normal load conditions for a period of one hour.

562) All new or replacement battery chargers shall be of the constant voltage type suitable for

the type battery applied to.

563) Batteries removed from service shall be properly disposed of.

APPENDICES

1. **AFTAC CIRCUITAPPLICATION GUIDELINES**
2. **B&M POLICY MEMO 45 – SERIES OVERLAY TRACK CIRCUIT EQUIPMENT**
3. **AFTAC CHANNEL SEPERATION LIST**
4. **EMERGENCY SWITCH RELEASE PROCEDURES**

APPENDIX 1 - AFTAC CIRCUITAPPLICATION GUIDELINES

SDP-1002-18

AFTAC CIRCUIT APPLICATION GUIDELINES

The following comprise conservative recommendations for the use of various Harmon AFTAC units. These should not be considered absolute rules, but something better than nothing, providing guidance based on several years of engineering experience.

1. In general, all reference to separation of channels means distance from any transmitter to an unrelated receiver. Unrelated receivers of the same frequency used on the same track should be separated by ten times the longer of the two circuits, but not less than 20,000 feet or two sets of insulated joints. Insulated joints bypassed by any type of tuned or untuned couplers for audio frequencies do not count for the purposes of this paragraph. Although tuned couplers have lowest loss at the frequency for which they are tuned, they cannot be relied upon to block any other frequency. Like receivers of the same frequency may be located closer together if they are both fed from transmitters located between them.

   Suggest any of the following as adequate separation:

   a. Ten times the longer of the two circuits (20,000 ft. min.) and no joints.
   b. Five times the longer of the two circuits (10,000 ft. min.) and 1 set joints.
   c. Two sets insulated joints (unbypassed).

2. Unrelated overlay of the same frequency on adjacent tracks should be located at least two miles apart. This restriction would not apply if the systems are separated by insulated joints on both tracks.

3. Adjacent channels should be located at least one mile apart on the same track. No restriction on adjacent channel separation when using different FM subtones on each channel.

4. When more than one receiver is driven off the same transmitter in the same direction, use receivers with high impedance input (Hi Z) receivers for any receiver located less than 1,000 feet from its transmitter.

   Generally a standard receiver could be as close as 500 feet from a center-feed transmitter without affecting the opposite receiver. The distance ratio of the longer circuit to the shorter is a factor, as in the frequency. For shorter circuits such as island and buffer applications, a useful rule of thumb would be D=500/f where F is in KHZ. If the longer circuit is more than twice as long as the shorter, and the shorter is less than D as defined above, then a Hi Z receiver should be used on the shorter.

5. Track leads should be #9 or larger. Invididual leads should not exceed 75 feet in length. Lengths to 150 feet may be used with #6 or pair of #9. When using longer leads, a rail-to-line coupler should be used. Receiver leads must be twisted if two receivers of the same frequency, or receiver and transmitter of same frequency, have leads in the same trench. Recommend track leads in case wiring be #10.

6. A receiver and transmitter may share the same track leads so long as frequencies are at least two channels apart and are not multiples of each other. If possible, receiver frequency should be the higher of the two.

   Good conservative practice. With separate FM subtones there is very little chance of false energization by adjacent channels, but swamping may result under adverse conditions. No need to make the receiver the high frequency when using FM.

7. Couplers for Harmon AFTAC are tuned couplers. If more than one frequency is to be bypassed around a set of insulated joints, separate couplers must be used. All couplers may share the same track leads with each other and with D.C. or coded track circuits.

8. When calculating current draw, use 0.5 amp for high power transmitters feeding one receiver no more than 1,000 feet away, 1.5 amps for other high power transmitters and 0.2 amp for receivers. Low power transmitters draw about .1 amp and island AFTAC units .3 amp.

9. A Harmon AFTAC receiver may be used with the transmitter of an island AFTAC attached to rail between its receiver and the separate receiver to give a 100' - 150' restart. Use the lower frequencies for the island AFTAC when used in this manner.

10. When using the island AFTAC, frequencies should not be reused on the same track within ten times the length of the longest circuit of that frequency unless separated by two sets of insulated joints.

    On very short range circuits a distance of 10 times the longer working circuit may not be sufficient. Suggest a pattern similar to that in paragraph 1, but using 20 times distance with no joints and 10 times distance with one set of joints.

11. Regarding the effect of a crossover between adjacent tracks on frequency separation, consider the crossover as making the two parallel tracks into a single track with one set of

insulated joints dividing the circuits. Hence the separation guideline 1b on page 1 would govern, going either direction on either track from the crossover.

12. As to the effect of longer leads, that is a pretty undefined area, but we have been using a very rough approximation of 1 foot of leads being equivalent to 10 feet of track as a starting point. This means an additional 50 feet of leads would shorten the useable circuit length by 500 feet. This is not a firm rule by any means, but may be of some use.

APPENDIX 2

C & S POLICY MEMO 45

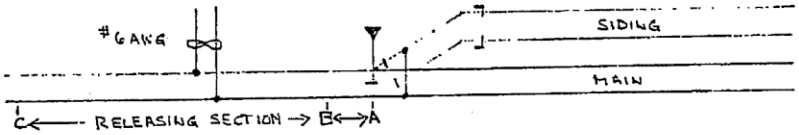
Subject: Series Overlay Track Circuit Equipment

Overlay equipment shall be set up and installed in accordance with the manufacturer's instructions for the type equipment used.

Storage batteries used to supply power to the overlay equipment must be kept in a fully charged condition and the voltage reading of the bank should be kept at a nominal 12.5 vdc but not exceeding 13.0 vdc.

Track leads for track overlay equipment used in electric lock release circuits shall be No. 6 AWG twisted every three feet. Maximum length shall not exceed 75 feet.

A sketch of a typical installation is as follows:



Distances A - B = 10 feet
B - C = 100 feet

Receiver and transmitter adjustment procedures shall be made in accordance with the following:

SAFETRAN SOTC (Series Overlay Track Circuits

A. Adjustment Procedures

1. Place a hardwire shunt at point B
2. Observing correct polarity, connect a voltmeter across terminals marked "relay".
3. Adjust pot slowly until relay closes its front contacts. Record voltage reading at this point.
4. Place hardwire shunt at switch points and observe relay does not pick up.
5. Place a hardwire shunt halfway between points A and B and observe relay does not pick up. If relay picks at this location, adjust pot until relay opens front contacts. Record this new voltage setting. Lock adjustment.
6. Place a hardwire shunt at the midway point between B and C and assure that relay closes its front contacts.

B. Troubleshooting Procedures

1. Check dc voltage at the unit; check fuses and check module tail plugs for cleanliness and proper seating.

2. If trouble persists, change out module.

GRS Series Overlay Track Circuits

A. Adjustment Procedures

1. Place hardwire shunt across the rails ten (10) feet away from the track leads furthest from the switch.

2. Turn adjustment resistor fully clockwise

3. Observing proper polarity, connect ammeter in series with the track relay, selecting a range that will give mid-scale readings.

4. With all strap connectors removed (or opened) on the tuner, record amperage reading.

5. By connecting or disconnecting straps, select the proper combination of inductances to give maximum relay current.

6. When maximum current has been selected, lock the strap connectors in their final position.

7. Disconnect ammeter and connect a voltmeter, across terminals 15 and 16.

8. With hardwire shunt still in place as described in 1. select from the following table the range of track relay current given for the input voltage read on terminals 15 & 16.

Tranceiver Input Voltage	Track Relay Current
9 vdc	105 - 110 ma
10 vdc	116 - 122 ma
11 vdc	128 - 134 ma
12 vdc	140 - 147 ma

9. Tighten lock nut on adjustable resistor after final setting of relay current and remove hardwwire shunt.

10. Connect shunt wire across rails 10 feet ahead of switch points and observe that track relay does not pick up. If it does pick up, readjust relay current.

B. Troubleshooting Procedures

1. Check dc voltage at the unit, check wiring connections, check variable resistor setting.

2. If trouble persists, change out tranceiver.

A block diagram of the overlay equipment may be found on the following page.

T. Trovato

Office of Chief Engineer
Communications & Signals
N. Billerica, MA
March 9, 1983

SH 1 OF 1

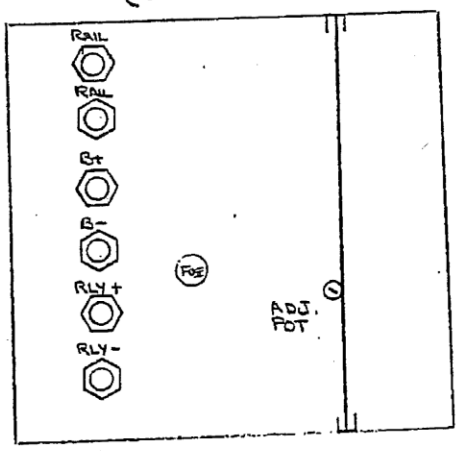
SAFETRAN

SOTC

SERIES OVERLAY TRACK CIRCUIT

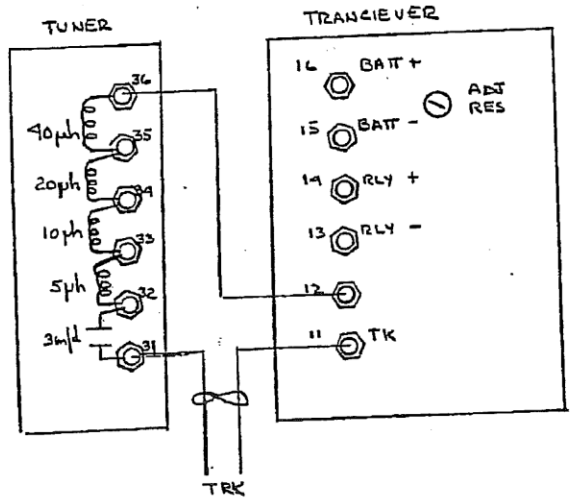
10 KHZ

(COVER REMOVED)



GRS

SERIES OVERLAY TRACK CIRCUIT



APPENDIX 3 - AFTAC CHANNEL SEPERATION LIST

CHANNEL	AFTAC II FREQUENCY	STANDARD SUBTONE	AMTRAK STANDARD HIGHWAY CROSSING APPLICATION
1	500 Hz	10 Hz	Universal Spare
2	700 Hz	17 Hz	Approach (Start) Circuit
3	900 Hz	24 Hz	" "
4	1.1 KHz	31 Hz	" "
5	1.3 KHz	38 Hz	" "
6	1.6 KHz	45 Hz (Note 1)	" "
7	1.9 KHz	52 Hz (Note 2)	" "
8	2.3 KHz	66 Hz (Note 3)	" "
9	2.8 KHz	73 Hz (Note 4)	" "
10	3.1 KHz	80 Hz	" "
11	3.5 KHz	87 Hz	" "
12	4.0 KHz	94 Hz	" "
14	4.9 KHz	108 Hz	" "
13	4.4 KHz	*101 Hz	* Do not use in cab signal territory.
20	8.3 KHz	45 Hz (Note 1)	Island Circuit
21	8.9 KHz	52 Hz (Note 2)	"
22	9.5 KHz	66 Hz (Note 3)	"
23	10.2 KHz	73 Hz (Note 4)	"

(Note 1): Do not use Channels 6 & 20 in same housing or in same location.

(Note 2): Do not use Channels 7 & 21 in same housing or in same location.

(Note 3): Do not use Channels 8 & 22 in same housing or in same location.

(Note 4): Do not use Channels 9 & 23 in same housing or in same location.

APPENDIX 4 - EMERGENCY SWITCH RELEASE PROCEDURES

EXAMPLE

Beverly Junction Emergency Switch Release Procedure (MBCR C&S 2 # 409)

In the event switches are locked during an emergency the following procedure may be used if authorized by Supervision.

1. **Call Dispatcher and ask what train movements are needed first and what position switches are needed.**
2. **Check that all signals in the Interlocking are at stop by verifying the Red Repeater relays (RPRs) listed are energized;**
   - **R2 RPR located at 1C2 is up.**
   - **R4 RPR located at 2C2 is up.**
   - **L2-8 RPR located at 1C7 is up.**
   - **L4-6 RPR located at 2C7 is up.**
   - **L10 RPR located at 4F5 is up.**
3. **Call Dispatcher and get permission to take Local Control of Interlocking. Advise Dispatcher that jumpers are being applied to release locking and that no train movements are to begin until you advise that jumpers have been removed.**
4. **Call Signal Manager on duty and get jumper permission to energize any of the following that are de-energized;**
   - **1 LR located at 1G4**
   - **3 LR located at 2E1**
   - **5 LR located at 3G7**
5. **Line switches into desired position one at a time from local control panel after lock relays have been energized.**
6. **Remove jumpers when switches are properly lined and verify position on model board.**
7. **Call Dispatcher and advise them that switches are lined as requested and that jumpers have been removed. Return model board to remote control.**