Massachusetts Bay Transportation Authority

Light & Heavy Rail Transit

SM.1

INSTRUCTIONS FOR TESTING SIGNAL APPARATUS AND SIGNAL SYSTEMS

MBTA SIGNAL MAINTENANCE

GENERAL SAFETY CONSIDERATIONS

- Employees(s) performing the tests must have information relative to train movements to ensure that the public and train traffic will not be endangered or delayed while tests are being performed. Also, it must be known that no unsafe conditions are set up by the application testing equipment.
- Established safety rules, procedures and practices shall be followed at all times during inspection and testing. Refer to the latest applicable standards and the latest edition of the Right-of-Way Safety Rulebook.

REVISION LOG:

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MBTA PMP TEST-2 (TEST OF INSULATION RESISTANCE)

2 MBTA PMP TEST 2 (TEST OF INSULATION RESISTANCE)

Purpose: Test is to ensure that the insulation of wires and connected apparatus meets with resistance values presented below.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Record of PMP TEST 2 results must be made on the form MBTA PMP TEST 2. All values must be recorded. The form must indicate the corrective action taken with those wires not meeting minimum requirements.

Results: Cables with conductors with insulation resistance below 1 Meg-ohm must be reported to Supervisor, who must report this to Deputy Director of Signals, to schedule this cable for replacement.

When insulation resistance of wire or cable is found to be less than 500,000 ohms, but not less than 200,000 ohms, prompt action must be taken to repair or replace the defective wire or cable.

No circuit will be permitted to function on any conductor having an insulation resistance to ground or between conductors of less than 200,000 ohms. Immediate corrective action must be taken and clearly recorded on the test form. Use the "remarks" column if necessary.

Frequency: **At least once every ten years -**

This test pertains to all Signal wires and cables except as noted below.

At least once every twelve months -

Wires and cables found having one or more conductors with insulation resistance less than 500,000 ohms, but not less than 200,000 ohms, until cable or wiring is re-placed.

NOTE: Signal power distribution cables shall be tested when placed in service and at the discretion of the Signal Supervisor. House and case wires shall be tested on an as required basis. Wires connected directly to track rails need not be tested. Communications type wires and cables need not be tested. Bond line wires from the rooms to the WeeZ bonds must be tested to each other and to ground at a voltage not to exceed 500 VDC.

Test Equipment: Test must be made with a calibrated Megger with a self-contained source of direct current test voltage. Megger must read from zero to 20 Megohms

minimum and be rated at 250 volts minimum. Each cable shall be tested at the maximum voltage that the wire insulation is rated for.

Procedure:

2.1 Tests shall be made when cables and insulation are dry. Record conditions on Test Form (Wet/Dry).

2.2 All provisions of E&M SM.2 covering the use of jumpers and safeguarding train movements, and other safety precautions, must be observed.

2.3 Test Megger operation prior to cable testing by insuring that the Megger reads infinity when the meter leads are open and zero when the leads are touched together.

2.4 Test that the terminal or buss being used as a ground is connected to ground by placing one lead of the Megger to a structure ground or track lead and placing the other lead to the ground terminal or buss. When operated, the Megger must read zero resistance.

2.5 Verify nomenclature (i.e. Spare 1, 27LTP, etc on tag) of each conductor to be tested at both ends of the cable and record the nomenclature on the test form. Use additional test forms for cables having more than 27 conductors. Note any discrepancies in the remarks column for the conductor.

2.6 At the start of testing, separate the first conductor in the cable to be tested from the house/case wire by opening test link or lifting cable wire from terminal at each end. **Note: Conductor being tested must be opened at both ends disconnected from circuitry and lightning arrestor before testing. Only one cable wire can be disconnected at each end at any time to avoid disarrangement and additional testing.** Have the person at the opposite end of the cable ground the conductor to be tested to ensure continuity end to end. Megger must read zero. After ensuring continuity lift the ground at the opposite end. Any wire identified as open must be tested from both ends to ensure it is not grounded or shorted to another conductor. If the wire is shown to be neither grounded nor shorted to another wire, there is no need to report as an annual test. Record results with (P) for Pass, (O) for open wire or (F) for fail if open wire is grounded or shorted to another wire.

2.7 After completing step 2.6, test the first conductor in the cable by meggering from this conductor to ground. Record results above 20 Meg-ohms as Inf. or use infinity sign (∞).Record anything below 20 Meg-ohms with actual ohm readings.

2.8 If insulation resistance to ground meets requirements, the testing of insulation between this conductor and all other conductors (Cross Meggering) may be made without disconnecting the other conductors. After finishing cross Meggering, restore wire connections before proceeding to next conductor. Record lowest resistance (in ohms) to any other conductor in the cable (if less than 20 Meg-ohms) and identify

that conductor in the remarks column. If resistance to other all conductors is above 20 Meg-ohms record Inf. or infinity sign (∞).

2.9 Repeat steps 2.5 thru 2.8 to complete the insulation resistance test of all conductors in the cable. **Note: Conductor being tested must be opened at both ends and disconnected from circuitry and lightning arrestor before testing. Only one cable wire can be disconnected at each end at any time to avoid disarrangement and additional testing.**

2.10 If any conductor in a cable tests less than 500,000 ohms but more than 200,000 ohms between conductors or to ground, identify this cable as a 1 year test. Otherwise check it off as a 10 year test.

CORRECTION OF DEFICIENCIES: Cables with conductors with insulation resistance below 1 Meg-ohm must be reported to Supervisor, who must report this to Deputy Director of Signals, to schedule this cable for replacement.
When insulation resistance of wire or cable is found to be less than 500,000 ohms, but not less than 200,000 ohms, prompt action must be taken to repair or replace the defective wire or cable.
When insulation resistance of a conductor is found to be less than 200,000 ohm to ground or another conductor, the affected conductors must be removed from service immediately. The Supervisor of Signal Engineering must notified and arrangements made for safe passage of trains until the problem is corrected.

Rev. 0 Date of Rev: 6/4/15
Approvals by: Director: Joseph Y. McNeil

MBTA PMP TEST-4 (TEST OF DC RELAYS AND OTHER ELECTROMAGNETIC APPARATUS)

4 MBTA PMP TEST 4 (TEST OF DC RELAYS AND OTHER ELECTRO MAGNETIC APPARATUS)

Purpose: Test is to ensure that operating characteristics of electromagnetic apparatus shall be maintained in accordance with the limits in which an apparatus is designed to operate.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Record operating characteristics on the test form MBTA PMP TEST-4. One copy is to be retained at location and the original is to be filed at the Office of Deputy Director of Signals.

Results: Any relay or electro-mechanical device that has failed the requirements of PMP Test 4 shall be removed from service and replaced immediately. If the relay cannot be replaced immediately, the Supervisor of Signal Engineering must be notified and arrangements made for the safe passage of trains.

Frequency: At least once every four years.

Test Equipment: Relay Test Unit for the type of relays tested and multimeter.

D.C. Neutral Relays & DC Biased Neutral Relays

Test General Rules:

- Field tests on DC relays shall be made in accordance with the manufacturer's instructions for field tests. In all cases, apparatus must comply with the manufacturer's instructions for field tests. The tests must also be made in accordance with the following instructions:
- For apparatus or systems not covered by these instructions, the instructions furnished by the manufacturer should be followed.
- In order to prevent disarrangement of the signal system, certain procedures must be followed while tests are performed:
  - On terminal type apparatus, only remove one coil wire at a time.
  - On plug-in or plug coupled apparatus, only remove one unit at a time. Each unit must be reconnected or reinstalled before another can be removed. Any relay plug board found without registration (key) plate must be reported to the Supervisor of Signals.

- Disarrangement takes place when more than one (1) wire is off at a time. If disarrangement takes place, all tests required will be performed to circuits involved.
- Forms for relays or other electro-mechanical devices must be properly filled out. Location of the relays shall be reported on the form and shall include (a) the route/line name and (b) interlocking or signal location as applicable. The location in the left column shall be specific to the engineering station, case or apparatus. Dates will include day, month and year.
- A location may have relays with different test frequencies. All relays shall be sorted on separate sheets according to their test frequency.

Procedure:

Inspection-

4.1 Inspect that the relay is in compliance with the following conditions:

- Index plate registration for each plug-in relay.
- That all parts of the relay are in good condition and in correct position with respect to other parts. Check that nomenclature tag is legible.
- That the glass or plastic cover is not cracked, broken, smoky, or discolored.
- That the ribbons are intact and in good condition and that the contacts are not worn, charred, pitted or have carbon build up.
- That the contacts are in alignment and contact openings are sufficient.
- That no moisture has accumulated inside the relay.
- That the relays have a positive drop-away and that the relay opens without any hesitation due to friction or other reason.
- That relays do not have pointers or cotton gaskets and repair or replace if necessary.

Test -

4.2 All GRS or Alstom B-1 relays must be inspected for signs of flaking or wear of the plating where the residual screw hits the core head or any build up of foreign material on the residual screw tip. Any relay showing any sign of flaking, wear or foreign material on the residual screw tip must be immediately removed from service.

4.3 Apply initial charge of working current in same direction as normal service energy. Gradually reduce the current until front contacts open; this is the drop-away value. Gradually increase current until contacts are just made; this is the pickup value. Further increase current until full stroke is obtained. When the stop pin is fully

against the armature this is the working current. Manufacturer's E.D. specification limits for field testing shall be adhered to. Any relays not conforming to the manufacturer's specifications shall be taken out of service immediately.

4.4 After opening circuit, apply voltage in normal direction and gradually increase until front contacts just close. The current measured when the front contacts just close is the pick-up value and should not be more than 10% above the original marking. Continue to gradually increase energy in the same direction until armature is against stop pin. This is the working current. Record pickup, drop away and working currents measured by 4.3 and 4.4.

4.5 Reverse drop-away and pick-up may be obtained by following the same procedure with polarity applied to coils in the reverse direction. Type VTB relays and other double (series) relays built on the same frame should be treated similar to a polar relay, obtaining values for both normal (front armature) and reverse (rear armature) actuation. Unless otherwise specified, the operating values are the same for both front and rear actuation.

4.6 To obtain the values of polar pick-up, apply initial charge to coils then decrease slowly to zero, open circuit, reverse direction and gradually increase energy until polar armature reverses its position and contacts just close. Determine polar pick-up and working values for each direction. Polar pick-up must not exceed 80% of neutral pick-up.

Note 1: An initial test voltage or current equal to service voltage or current must be applied to all D.C. Relays and Electromagnetic devices before taking a drop-away reading.

Note 2: The phrase "original marking" applies to the manufacturer's specifications unless superseded by a Relay Repair Shop Data Tab.

Note 3: For ***D.C. Biased Neutral:*** Before returning the relay to service, reverse the energy to the coils of the relay. Relay must remain in the fully de-energized position.

CORRECTION OF DEFICIENCIES: DEFICIENT RELAYS MUST BE IMMEDIATELY REPLACED, TAGGED AND SENT TO THE RELAY SHOP. If the relay cannot be replaced immediately, notify the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

Rev. 0 Date of Rev: 6/4/15
Approvals by: Director: Joseph T. McGill

MBTA PMP TEST-5 (TEST OF AC RELAYS)

5 MBTA PMP TEST 5 (TEST OF AC RELAYS)

Purpose: Test is to ensure that operating characteristics of electromagnetic apparatus shall be maintained in accordance with the limits in which an apparatus is designed to operate.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Record operating characteristics on form MBTA PMP TEST 5. One copy is to be retained at location and the original is to be filed at the Office of Deputy Director of Signals.

Results: Any relay or electro-magnetic device that has failed the requirements of PMP Test 5 shall be removed from service and replaced immediately. If the relay cannot be replaced immediately, the Supervisor of Signal Engineering must be notified and arrangements made for the safe passage of trains.

Frequency: At least once every two years.

Test Equipment: Relay Test Unit for AC vane relays and multimeter.

AC Vane Relays Testing Rules:

- Field tests on AC relays shall be made in accordance with manufacturer's instructions for field tests. In all cases, apparatus must comply with the manufacturer's instructions for field tests.
- For apparatus or systems not covered by these instructions, the instructions furnished by the manufacturer should be followed.
- In order to prevent disarrangement of the signal system, certain procedures must be followed while tests are performed:
  - On terminal type apparatus, only remove one coil wire at a time.
  - On plug-in or plug coupled apparatus, only remove one unit at a time. Each unit must be reconnected or reinstalled before another can be removed. Any relay plug board found without registration (key) plate must be reported to the Supervisor of Signals.
- Disarrangement takes place when more than one (1) wire is off at a time. If disarrangement takes place, all tests required will be performed to circuits involved.

- Forms for relay or other electromagnetic devices must be properly filled out. Location on the heading will include the (a) route/line name and (b) interlocking or signal location as applicable. The location in the left column shall be specific to the engineering station, case or apparatus. Dates will include day, month and year

- A location may have relays with different test frequencies. All relays shall be sorted on separate sheets according to their test frequency.

Procedure: ***Relay Inspection***

5.1 Inspect that the relay is in compliance with the following conditions:

- Verify index plate registration for each plug-in relay.
- That all parts of the relay are in good condition and in correct position with respect to other parts. Check that nomenclature tag is legible.
- That the glass or plastic cover is not cracked, broken, smoky, or discolored.
- That the ribbons are intact and in good condition and that the contacts are not worn, charred, pitted or have carbon build up.
- That the contacts are in alignment and contact openings are sufficient.
- That no moisture has accumulated inside the relay.
- That the relays have a positive drop-away and that the relay opens without any hesitation due to friction or other reason.
- That relays do not have pointers or cotton gaskets and repair or replace if necessary.

A.C. Dual Element Vane Relay Test

5.2 For Shelf Type disconnect the RB track control wire from the operating winding, leaving the local control wires intact. Apply relay test equipment.

5.3 Apply an initial charge of energy to the winding of the relay with the polarity normal. Ensure that the relay is fully picked up on the normal contacts.

5.4 Slowly decrease the applied voltage until the point where the normal contacts open. Record this value as "Normal Drop-away'.

5.5 Gradually increase the voltage to the relay until the normal contacts just close. Record this value as "Normal Pick-up".

5.6 Continue to increase the voltage until the armature moves up to the stop position. Record this value as "Working Normal".

5.7 Ensure that the vane moves freely without binding or chafing. Observe that there is a uniform clearance between each side of the vane and the pole faces.

5.8 Ensure that the values are within tolerances for that particular relay.

5.9 Replace control wires on Shelf Type to return the relay to service.

CORRECTION OF DEFICIENCIES: DEFICIENT RELAYS MUST BE IMMEDIATELY REPLACED, TAGGED AND SENT TO THE RELAY SHOP. If the relay cannot be replaced immediately, notify the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

Rev. 0 Date of Rev: 6/4/15
Approvals by: Director: Joseph T. McNall

MBTA PMP TEST-7 (TEST OF SIGNAL INDICATION LOCKING)

7 MBTA PMP TEST 7 (TEST OF SIGNAL INDICATION LOCKING)

Purpose: To ensure that a signal route stays locked.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Results of PMP TEST 7 are to be recorded on Form MBTA PMP TEST-7. All forms must be forwarded to the Office of the Deputy Director of Signals.

Results: If any discrepancies are found during testing the Inspector shall immediately notify the Supervisor of Signal Engineering, and arrangements made for the safe passage of trains.

NOTE: PMP TEST-7, TEST-8 (if applicable), TEST-9, TEST-11 and TEST-15 may be done together for each route.

Frequency: At least once every two years, or if circuits or devices are changed or disarranged.

Procedures:

Test 7A **At all relay interlockings:**

7.1 Record all signals in the interlocking to be tested.

7.2 Record all switches in the route to be tested.

7.3 Clear home signal by initiating request.

7.4 Check and record that all switches, movable point frogs, derails, and any other appliances in the route are properly lined and locked.

7.5 Check and record that the corresponding H or G relay is up and ALSR (ASR) relays are down.

7.6 Attempt to clear opposing and conflicting signals if applicable, signals should not clear.

7.7 In cab signal territory simulate a train taking the route by dropping the first track circuit approaching the interlocking and then the first track circuit inside the interlocking. Then simulate an overrun of a conflicting signal. Verify in each overrun case that cab signals for all track circuits in the interlocking turn off.

7.8 Check that all switch (and other appliance) lock indication lights in the routes are properly displayed. Place signal in stop position by initiating stop or cancel request.

7.9 Check and record that all appliances listed in Steps 2, 3 & 4 remain locked, that corresponding H or G relays are down, that ALSR (ASR) relay remains down until time expires (see Test 8 or 9) and that all applicable lock indication lights remain displayed.

7.10 Energize each specific signal control relay (G or H) in circuit and verify switches in route are locked.

7.11 Open or shunt track relays progressively to allow ALSR (ASR) to pick up. At all relay interlockings, observe that all switch (or other appliance) lock indication lights show switches (and other appliances) are released.

CORRECTION OF DEFICIENCIES: Deficiencies identified during Signal Indication Locking tests shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

Test 7B **<u>At Microprocessor Interlockings</u>:**

7.12 Record all signals in the interlocking to be tested.

7.13 Record all switches in the route to be tested.

7.14 Clear home signal by initiating request.

7.15 Verify, LR and ALSR (ASR) functions are down by checking that the assigned LED Indicators (if used) on the Vital processor output board are out. The status of, LR and ALSR (ASR) circuits should be confirmed by using a laptop computer/system terminal to verify that these functions are false.

7.16 Verify that all switches, movable point frogs, derails, and any other appliances in the route are properly aligned and locked, that corresponding ALSR (ASR) function is false and that all switch (and other appliances) lock indication lights in the routes are properly displayed. Place signal in stop position by initiating stop or cancel request.

7.17 Verify that all appliances listed in 7.13, remain locked, that corresponding ALSR (ASR) functions remain false until time expires (see Test 8 or 9) and that all applicable lock indication lights remain displayed.

CORRECTION OF DEFICIENCIES: Deficiencies identified during Signal Indication Locking tests shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

Rev. 0 Date of Rev: 6/4/15
Approvals by: Director: Joseph T. McNally

MBTA PMP TEST-8 (TEST OF APPROACH LOCKING)

8 MBTA PMP TEST 8 (TEST OF APPROACH LOCKING)

Purpose: To ensure that while a train is approaching a cleared signal, the route cannot be changed or opposing signal cleared until after the signal is set to its most restrictive aspect, and the predetermined amount of time has expired.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Results of PMP TEST 8 are to be recorded on FORM MBTA PMP TEST 8. All forms must be forwarded to the Office of the Deputy Director of Signals.

Results: If any discrepancies are found during testing the Inspector shall immediately notify the Supervisor of Signal Engineering, and arrangements made for the safe passage of trains.

NOTE: PMP TEST 7, TEST 8 (if applicable), TEST 9, TEST 11 and TEST 15 may be done together for each route.

Frequency: At least once every two years or if circuits are changed or disarranged.

Test Equipment: Time piece accurate to 1 second.

Procedure: Check Approach Locking As Follows:

8.1 Record Signal route to be tested per Signal Drawings.

8.2 Record Approach Relay Name.

8.3 Record track circuits contained in each approach relay per signal plans.

8.4 Record Switches in Route.

8.5 Verify that approach relay is de-energized when each track circuit in the approach is dropped.

8.6 Record approach timer name and settings (time) per signal plans.

8.7 Clear home signal for the route to be tested.

8.8 Open approach relay.

8.9 Place signal to stop position by initiating stop or cancel request.

8.10 Check that all switches, movable point frogs, and derails in the route are locked. After specified time has expired. Check that locking is released.

8.11 Close approach relay. Record results on test sheet. (Pass/Fail).

8.12 Where overlap locking of switches in a second interlocking by signals in a first interlocking is implemented:

- Cancel the signals in the second interlocking.
- Based upon the plans clear the signal and drop the track circuit in the first interlocking which initiates overlap locking in the second interlocking.
- Record the design time for the OLSTE timer.
- Record the switches locked by Overlap locking.

8.13 Verify that the switches in the second interlocking remain locked.

8.14 Simulate train movement into the release track circuit and verify that the OLSTE timer runs and that the switches are released when the timer has completed its time.

CORRECTION OF DEFICIENCIES: Deficiencies identified during approach locking tests shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

Rev. 0 Date of Rev: 6/4/15
Approvals : Director: Joseph T. McNall

MBTA PMP TEST-9 (TEST OF TIME LOCKING)

9 MBTA PMP TEST 9 (TEST OF TIME LOCKING)

Purpose: To ensure that a route cannot be changed or opposing signal cleared until after the signal is set to its most restrictive aspect and a predetermined amount of time has expired.

Responsibility: Signal inspector, Foreperson, and Wireperson.

Records: Results of MBTA PMP TEST 9 are to be recorded on Form MBTA PMP TEST 9. All forms must be forwarded to the office of the Deputy Director of Signals.

Results: If any discrepancies are found during testing the Wireperson shall immediately notify the Supervisor of Signals, and arrangements made for the safe passage of trains.

NOTE: PMP TEST 7, TEST 8 (if applicable), TEST 9, TEST 11 and TEST 15 may be done together for each route.

Frequency: At least once every two years or when time locking is changed or disarranged.

Test Equipment: Time piece accurate to 1 second.

Procedure: Check Time Locking as follows:

9.1 Record the signals of the route to be tested per signal plans.

9.2 Record the switches and their position in the route to be tested.

9.3 Record the opposing/conflicting signals of the route to be tested.

9.4 Record the name and time interval of the AS timer of the route to be tested.

9.5 Clear the signal over the route to be tested.

9.6 Cancel the route by setting the signal to stop.

9.7 Return signal to clear.

9.8 Cancel signal again.

9.9 Ensure that the timer relay is operating.

9.10 Check that all switches in the route remain locked until after the pre-determined time has expired. Record results on test sheet (Pass/Fail).

9.11 Check that opposing or conflicting routes cannot be established until the pre-determined time has expired.

9.12 Ensure route releases after time has expired/run down. Record results on test sheet (Pass/Fail).

9.13 Repeat process for all routes in the interlocking.

CORRECTION OF DEFICIENCIES: Deficiencies identified during time locking tests shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

Rev. 0 Date of Rev: 6/4/15
Approvals by: Director: Joseph T. McNall

MBTA PMP TEST-10 (TEST OF TIME RELEASES, TIMING RELAYS AND TIMING DEVICES)

10 MBTA PMP TEST 10 (TEST OF TIME RELEASES, TIMING RELAYS AND TIMING DEVICES)

Purpose: To ensure that safety is not compromised due to improper timing delay.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Applicable Documents:

Records: Results of MBTA PMP TEST-10 shall be recorded for all Time Releases, Timing Relays and Devices on Form MBTA PMP TEST 10 showing the time on the plan or device and the actual time found in the field. All forms must be forwarded to the Office of the Deputy Director of Signals.

Results: Any relay or device with a time not within 10% +/- of design time shown on the plans shall immediately be adjusted or replaced and action must be taken for the safe passage of trains.

Frequency: At least once each year.

Test Equipment: Time piece accurate to 1 second.

Procedure: ***Inspect and Test the timers as follows***

10.1 Record the name of the timer to be tested.

10.2 Record the serial number of the timer to be tested.

10.3 Ensure that timer is set to the time designated on circuit plans. Record time results (Pass/Fail).

10.4 Check that the seals for timing devices are intact and have not been tampered with. Record the results.

10.5 Activate the timer per one of the procedures outlined in 10.6, 10.7, and 10.8 below. Record the amount of time the timer takes to complete its cycle and ensure that it is within 10% +/- of design time. (Note: For timing relays use an independent timing device to verify accuracy).

10.6 **Test Procedures For Electric Locks equipped with Timing Relays:**

- Start timing relay by unlocking and removing padlock from switch cradle.
- Time until switch is unlocked.

10.7 **For Timing Relays at Controlled Signals:**

- Clear the signal to be tested.
- De-energize the approach relay (if applicable).
- Restore the signal to stop.
- Measure the time until the Approach Locking Stick Relay (ALSR) or ASR relay energizes.

10.8 **For Loss of Shunt Timing Devices:**

- De-energize the controlling relay of the LOS (TR relay, AR relay, etc.).
- Re-energize the controlling relay of the LOS (TR relay, AR relay, etc.).
- Measure the time until the repeater relay controlled by the LOS (TR relay, AR relay, etc.) picks up.

CORRECTION OF DEFICIENCIES: Deficiencies identified during timer tests shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

Rev. 0 Date of Rev: 6/4/15
Approvals by: Director: Joseph T. McNulty

MBTA PMP TEST-11 (TEST OF SWITCH INDICATION LOCKING)

11 MBTA PMP TEST 11 (TEST OF SWITCH INDICATION LOCKING)

Purpose: Test is to ensure that no signal may be displayed over a switch, moveable point frog, or derail which has failed to operate to the corresponding position of its controlling device.

Note: This test may be done in conjunction with PMP Tests 7, 8 (if applicable), 9 and 15.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Applicable Documents:

Records: Results of PMP TEST 11 shall be recorded on Form MBTA PMP TEST 11. All forms must be forwarded to the office of the Deputy Director of Signals.

Frequency: At least once every two years.

Test Equipment: Multimeter and switch obstruction gauge.

Procedure:

11.1 Point Detection Correspondence Check

- Record the number of the switch to be tested.
- Place a ½"obstruction in the reverse switch point and operate the switch against the obstruction. Ensure that the relay being used for reverse switch correspondence is de-energized.
- Attempt to clear signals over that route.
- Repeat above steps for the normal point.
- Remove obstruction.
- Place voltmeter on switch indication circuits or switch indication relay and open all switch machine contacts including hand throw/power lever, one at a time. Verify that the switch repeater relay opens on each contact opening. Repeat the same operation for the opposite switch position. Perform this test for each switch machine including both ends of a crossover.

11.2 Dog Leg Test - On crossovers, perform dog leg test as follows:

- With crossover in normal position and indicating, pull fuse in motor control for switch machine (A) being tested. Call switch to reverse position. When switch machine (B) has completed its move to reverse position, check that the reverse and normal switch repeater relays are in the de-energized position. Reinstall fuse on switch machine (A). After the machine has completed its move to the reverse position and locked up observe that the reverse switch repeater is in the energized position.

- Pull fuse in motor control for switch machine (A) again and call for switch to normal position. After switch machine (B) has completed its move to the normal position, check that the reverse and normal switch repeater are in the de-energized position. Reinstall fuse on switch machine (A). After the machine has completed its move to the normal position and locked up observe that the switch repeater relay is in the energized position.

- Repeat for (B) switch machine.

11.3 When steps 11.1 thru 11.2 are completed above verify and record that for each route in interlocking that dropping of the switch repeater relay for each switch results in that governing signal going back to stop.

11.4 Record each route to be tested on the Test Form.

11.5 Record all the switches and their position in the Route tested on the Test Form and the results.

CORRECTION OF DEFICIENCIES: Deficiencies identified during tests shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of train.

Rev. 0 Date of Rev: 6/4/15
Approvals by: Director: Joseph T. McNall

MBTA PMP TEST-12 (TEST OF SWITCH INDICATION LOCKING –ELECTRIC LOCKS)

12 MBTA PMP TEST 12 (TEST OF SWITCH INDICATION LOCKING-ELECTRIC LOCKS)

Purpose: Test is to ensure that electric locks operate as intended.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Results of PMP TEST 12 are to be recorded on Form MBTA PMP TEST 12. All forms must be forwarded to the Office of the Deputy Director of Signals.

Results: If any discrepancies are found during testing the Wireperson shall immediately notify the Supervisor of Signals, and arrangements made for the safe passage of trains.

Frequency: For switches without local time release feature, at least once every two years. For switches with local time release feature, at least once every year.

Test Equipment: Multimeter, time piece accurate to 1 second.

Procedure: Switches with local time release feature:

12.1 Record the name of electric locked switch to be tested.

12.2 Carefully inspect the electric lock for missing or worn parts, which might render the electric lock ineffective. Ensure that all wires are properly tagged and clear of all moving parts.

12.3 With the normal switch repeater energized, verify that the governing signals are clear or in case of cab signals that proper unrestricted code rates are present.

12.4 Place meter on coils of the normal switch repeater relay. Using circuit drawings, open each contact in the circuit (electric lock and switch contacts) verifying relay drops with each contact opening.

12.5 Remove switch pad lock from lock cradle to initiate start of time interval. While time is running, ensure that governing signal or cab signals display their most restrictive aspects. Verify that the operating handle for the hand-operated switch cannot be moved past the electric lock restraint. After specified time interval has expired, check that the lock is unlocked by moving switch handle to fully reverse position.

12.6 Check Latch Bar Test – On electric locks with Latch Bar, check that when switch is reverse that latch rod prevents switch padlock from being installed. If switch is not equipped with latch rod, perform dog leg test by reversing switch and re-installing padlock in the electric lock cradle and checking that the normal switch repeater is not energized.

12.7 When track is signaled for both directions, verify that when normal switch repeater is de-energized, signal or cab signal displays the most restrictive aspect no matter which direction of traffic is set.

12.8 Where there is a reverse switch repeater circuit for signaling over the switch in the reverse position, reverse the switch and check that reverse switch repeater circuit energizes. Check that the signal displays the appropriate aspect to proceed over the switch in the reverse position.

12.9 With Switch in reverse position, open Reverse Contacts and ensure that reverse switch repeater drops and signal or cab signal go to their most restrictive state.

CORRECTION OF DEFICIENCIES: Deficiencies identified during test shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

Rev. 0 Date of Rev: 6/4/15
Approvals by: Director: Joseph T. McNally

MBTA PMP TEST-13 (TEST OF SWITCH OBSTRUCTION)

13 MBTA PMP TEST 13 (TEST OF SWITCH OBSTRUCTION)

Purpose: Test is to ensure that when switch points including moveable point frogs are fully closed, they will be prevented from opening more than ¼" by lock rods. If wide notch locking pieces are used on 5F switch machine, switch points will be prevented from opening more than 3/8" by locking rods.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Results of PMP TEST 13 shall be recorded for all switch points on form MBTA PMP TEST 13 and forwarded to the Office of the Deputy Director of Signals.

Results: If any discrepancies are found during testing, the Wireperson shall immediately make the proper adjustments to ensure the switch passes the test. Any lock rod that is found worn or damaged shall be immediately replaced. If repairs or adjustments cannot be made immediately, the Supervisor of Signal Engineering must be notified and arrangements made for the safe passage of trains.

Frequency: At least once every month or if any part of the switch layout that affects switch locking is modified or disarranged.

Test Equipment: Switch obstruction gauge and hand crank.

Procedure: Conduct PMP TEST 13 as follows:

13.1 Record the nomenclature of the switch machine being tested.

13.2 Record Model of the switch machine to be tested (i.e. GRS 5F, US&S M23).

13.3 Inspect the general condition of switch layout, which may affect reliability and safety, such as surfacing, ties, braces, rods, points, stock rails, nuts, bolts, cotter pins, and switch heaters.

13.4 Inspect general condition of switch machine which may affect reliability and safety including:

- Check that hand throw switches operate properly.
- Check for play and lost motion in switch operation due to worn pins, worn head timbers, defective or worn cranks, loose rods etc.
- Ensure that the slide plates are adequately lubricated.
- Check the position of the points normal and reverse to ensure they lay flush against the stock rail.
- Hand crank switch to the full normal locked position and full reverse locked position. Ensure that no strain is apparent on any of the moving parts. Also

check the normal and reverse position of the locating notches* on the top of each lock rod and point detector rod corresponds with the respective switch points.

- Check that the electrical contacts close and open properly, are not burnt or bent and that wiring is not chaffed or loose.
- Check motor commutator and brushes for wear.

***NOTE: these notches are to be used as reference only.**

13.5 Place 1/4" switch obstruction gauge (3/8" if wide notch locking (5F) machine) between the open point and the stock rail 6" from the point. Hand-crank the switch machine to close the point firmly against the obstruction. Verify switch machine does not lock and fails to indicate. If switch locks, determine cause and adjust rods correctly. Perform test for both normal and reverse positions.

13.6 **Hand throw Obstruction Test – (GRS Model 5 Switch Machines Only)** The test shall be made by placing a 1/2-inch obstruction in the open point. Then place the switch machine in the hand-throw mode, move the switch point against the obstruction and assure that the switch lever cannot be moved to the full normal or reverse position. This test shall be made for both the normal and reverse positions.

13.7 **Hand throw Obstruction Test – (US&S Model 23 Switch Machines)** The test shall be made by placing a 1/2-inch obstruction in the open point.Then place the switch machine in the hand-throw mode, move the switch point against the obstruction and assure that the switch lever cannot be moved to the full normal or reverse position. This test shall be made for both the normal and reverse positions.

CORRECTION OF DEFICIENCIES: Deficiencies identified during Switch Indication locking tests shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

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Approvals by: Director: Joseph T. McNall

MBTA PMP TEST-14 (TEST OF AUTOMATIC TRAIN STOP)

14 MBTA PMP TEST 14 (TEST OF AUTOMATIC TRAIN STOP)

Purpose: Test is to ensure that Automatic Train Stop is maintained in accordance with the limits in which the apparatus is designed to operate.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Record PMP TEST 14 operating characteristics on form MBTA PMP TEST 14. One copy is to be retained at location and the original is to be filed at the Office of the Deputy Director of Signals.

Results: If any discrepancies are found during testing, the maintainer shall immediately make the proper adjustments to ensure the Automatic Train Stop passes the test. Any part of the trip stop that is found worn or damaged shall be immediately replaced. If repairs or adjustments cannot be made immediately, the Supervisor of Signals must be notified and arrangements made for the safe passage of trains.

FREQUENCY:

- MECHANICAL / VISUAL INSPECTION PROCEDURE – MONTHLY
- LUBRICATION PROCEDURE – MONTHLY

* Inspections and testing shall be performed at the frequencies listed above; prior to placing in service; when modified, repaired, disarranged; or as otherwise deemed necessary.

APPLICABLE DOCUMENTS:

- US&S Service Manual 5730

Test Equipment: Trip arm gauge and hand tools.

PROCEDURES:

MECHANICAL / VISUAL INSPECTION PROCEDURE – MONTHLY

14.1 On the data sheet record the name/number of trip under test.

14.2 Visually inspect that the trip arm is fastened securely to the rocker shaft.

14.3 With the trip arm in the stop position, check that the distance is **7 ½" (+/- ¼")** between the center of the trip arm and the gauge side of the running rail. Record the distance on the data sheet. Adjust if out of tolerance.

14.4 With the trip arm in the stop position, check that the height is **3 ½" (+/- ¼")** between the top of the rail and top of the trip arm. Record the height on the data sheet. Adjust if out of tolerance.

14.5 Gears must run freely and show no tendency to bind in any position.

14.6 Visually inspect the trip stop contacts for freedom of moving parts. There must be no tendency to bind in any position. Make repairs necessary to restore freedom of movement.

14.7 Visually inspect contact conditions and clean if necessary. The nibs on contact fingers should have approximately 1/16" opening. Replace if necessary. This adjustment permits a reasonable flat contact when the movable arm contact enters the nibs on the contact finger.

14.8 Occasionally clean the ventilator screens and replace if necessary.

14.9 Visually inspect the trip arm, rocker shaft, shims, bearing straps, mounting plate and mechanism case.

14.10 Check for secure mounting of the trip heater. Check the heater fuse. Verify that the heater warms up when the heater is turned on.

LUBRICATION PROCEDURE – MONTHLY

14.11 Remove the 1" pipe plug to apply the transmatic transmission fluid inside the gear box.

14.12 Use a pressure grease gun to lubricate the two mechanism main shaft bearings and the tripper arm bearing. **NOTE:** Occasionally check and add sufficient fluid to keep its level 1 ½" above the bottom of the case.

14.13 Oil the circuit controller slides and linkage pin.

CORRECTION OF DEFICIENCIES: Deficiencies identified during inspection shall be documented on the proper forms and corrected in accordance with OEM and/or MBTA requirements. If defects cannot be repaired immediately the wireperson must notify OCC and Signal Inspector. Arrangements must be made for safe passage of trains.

Rev. 0 Date of Rev: 6/4/15
Approvals by: Director: Joseph C. McNall

MBTA PMP TEST-15 (TEST OF ROUTE LOCKING)

15 MBTA PMP TEST 15 (TEST OF ROUTE LOCKING)

Purpose: Test is to ensure that the route remains locked in advance of a train that has accepted a signal to proceed into that route, and that switches remain locked under the train.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Results of PMP TEST-15 Route Locking are to be recorded on Form MBTA PMP TEST 15, showing track circuits shunted and switches locked. All forms must be forwarded to the Office of the Deputy Director of Signals.

Results: If any discrepancies are found during testing the Inspector shall immediately notify the Supervisor of Signals and make arrangements for the safe passage of trains.

NOTE: PMP TEST 7, TEST 8 (if applicable), TEST 9, TEST 11 and TEST 15 may be done together for each route.

Frequency: At least once every two years, and on new installations or when subsequent changes to existing installations are made.

Test Equipment: Shunt Strap.

Procedure:

15.1 Record the signals in the route to be tested (Entrance/Exit) on Test Form.

15.2 Record the track circuits in the route to be tested on Test Form.

15.3 Record the switches in the route to be tested on Test Form.

15.4 Line the switches for the route to be tested.

15.5 Clear the home signal for the route to be tested, and ensure a permissive aspect is displayed, and the approach is not occupied.

15.6 Drop the first track circuit (within the interlocking) beyond the governing signal or open the first track circuit relay of the route tested and verify that the signal displays its most restrictive aspect (red).

15.7 Cancel signal request, and ensure signal request has cancelled.

15.8 Check that time or approach locking has released. At interlockings where two-track circuit release and is in use, it will be necessary to momentarily drop the second track circuit in the route to release the time or approach locking.

15.9 After approach or time locking has released and the approach stick relay (ASR) is energized, check that all switches in the route remain locked.

15.10 For routes with more than one track circuit, shunt track and open applicable relays progressively for the entire route.

15.11 Where sectional route release is utilized, note which switches are unlocked and in which track they are released during the test on the test form.

Note1: Where sectional route release is utilized, additional verifications are necessary to determine that routes involving improper clearances cannot be established to the rear of the route under test.

Note 2: In lieu of shunting each track circuit, track repeaters may be opened to perform this test provided that the integrity of each track repeater in the interlocking is tested by shunting each individual track circuit and observing that its corresponding track repeater is opened. Also ensure that the track repeater is used in the route locking circuit and not the track relay. If the track relay is used then the track circuit will have to be shunted or the track relay opened.

15.12 Repeat test for each route.

CORRECTION OF DEFICIENCIES: Deficiencies identified during route locking tests shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

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Approvals by: Director: Joseph F. McNall

MBTA PMP TEST-16 (TEST OF TRAFFIC LOCKING)

16 MBTA PMP TEST 16 (TEST OF TRAFFIC LOCKING)

Purpose: Test is to ensure that once a signal has been cleared into a section of track, or a train has entered a section of track, the direction of traffic cannot be changed nor can opposing signals be cleared into that section.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Results of PMP TEST 16 Traffic Locking are to be recorded on Form MBTA PMP TEST 16 showing track circuits shunted and traffic locked. All forms must be forwarded to the Office of the Deputy Director of Signals.

Results: If any discrepancies are found during testing the Wireperson or Signal Inspector performing the test shall immediately notify the Supervisor of Signal Engineering and make arrangements for the safe passage of trains.

Frequency: When new installations are placed in service or when any portion is modified or disarranged or every two years.

Procedure:

16.1 Record the Signal Nomenclature of the Entering Signal in the Interlocking on Test Form.

16.2 Record the Signal Nomenclature of the Opposing Signal in the adjacent Interlocking on Test Form.

16.3 Record the name of the traffic block to be tested on Test Form.

16.4 Record the track circuits in the traffic block to be tested on Test Form.

16.5 Clear signal on normal route, establishing traffic direction.

16.6 Check that opposing signal on normal route cannot be displayed, and that traffic direction cannot be changed. Record results on test form.

16.7 Open first track circuit in route.

16.8 Cancel signal request for signal being tested.

16.9 After approach or time locking has released, check that direction of traffic cannot be changed.

16.10 Drop each track circuit progressively checking that the traffic direction cannot be changed and the opposing signal cannot be displayed. Ensure that the next track

circuit in the route is down before releasing the proceeding track circuit. Work progressively from initial signal to next interlocking where opposing signal is located.

16.11 Record all additional signals entering that track's traffic block.

NOTE: This test must be performed by clearing signals at the Local Control panels in the field. This test should not be done using OCC to clear signals.

CORRECTION OF DEFICIENCIES: Deficiencies identified during test shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. If deficiencies can not be immediately repaired, notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

Rev. 0 Date of Rev: 6/4/15
Approvals by: Director: Joseph C. McNall

MBTA PMP TEST-17 (TEST OF SIGNAL/TAK HEAD INSPECTION)

17 MBTA PMP TEST 17 (TEST OF SIGNAL/TAK HEAD INSPECTION)

Purpose: Inspection is to ensure proper placement and condition of the signal/TAK lenses, wiring and lighting apparatus.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Results of PMP TEST 17, Signal/TAK Head Inspection, are to be recorded on Form MBTA PMP TEST 17. All forms must be forwarded to the Office of the Deputy Director of Signals.

Results: If any discrepancies are found during testing the maintainer shall immediately notify the Supervisor of Signals and make arrangements for the safe passage of trains.

Frequency: At least once each year.

Procedure:

17.1 Record nomenclature of Signal/TAK on Test Form.

17.2 Ensure signal/ TAK lenses are proper color, clean and securely attached.

17.3 Ensure wiring in the unit is not damaged and is properly routed.

17.4 Ensure all light bulb sockets are clean, lamps or light Emitting Diodes are lit, cleaned and properly aligned.

17.5 Ensure Signal/TAK unit is properly focused.

17.6 Ensure that the signal head is free of debris.

17.7 Ensure that the line of sight to the signal is not blocked by vegetation.

17.8 Check lamp voltage and adjust if necessary.

17.9 Record voltage on PMP TEST 17. Voltage should not exceed Bulb rating. Record voltage of each lamp in Unit.

CORRECTION OF DEFICIENCIES: Deficiencies identified during Signal Head Inspection & Tests shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signals and make arrangements for safe passage of trains.

MBTA PMP TEST-18 (TEST OF GROUNDS)

18 MBTA PMP TEST 18 (TEST OF GROUNDS)

Purpose: To detect any grounded wires or power busses which could compromise the safety and integrity of the signal system.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Report results of PMP TEST 18 on ground tests on form MBTA PMP TEST 18.

Results: Grounds in excess of that expressed below must be eliminated at once. Any ground that cannot be located must be reported to the Supervisor of Signal Engineering immediately.

Frequency: At least once every month. Check each buss in house or case for grounds. Care shall be taken in observing proper operation of the test device in accordance with the manufacturers' instructions. At locations that have been burned out by fire or have experienced lightning or power surges, ground readings must be taken on all associated wires and apparatus immediately.

NOTE: This test is not required on track circuit wires, AC distribution wires or common return wires of grounded common single break circuits.

Test Equipment: Multimeter.

Procedure for DC voltage potentials:

18.1 Record nomenclature of buss to be tested on Test Form.

18.2 Test is made by measuring voltage potential between each energy bus and ground. If a voltage potential between an energy bus and a ground is detected, a current reading shall be taken to determine whether a ground exists in excess of that permitted by this test. **No ammeter tests may be conducted with any trains in the area controlled by the case or signal room.**

18.3 Connect positive meter lead of voltmeter to a positive energy buss and connect the negative meter lead to a known ground. If voltage is read, there is an apparent negative ground.

18.4 Make a similar test on the negative energy buss by connecting the negative meter lead to the negative buss and connect the positive lead to a known ground. If voltage is read, there is an apparent positive ground.

18.5 If voltage is detected, the amount of current flow to ground must be measured by inserting an ammeter between the buss and ground to determine whether a true ground exists. When it is determined that a ground exists, use of an ammeter will provide a tolerance level. Record current level of ground.

Note: Care should be exercised in use of an ammeter with respect to the movement of trains and the integrity of the signal system. Applying an ammeter between battery and ground can be the second path that completes an undesired operation and/or indication. **No ammeter tests may be conducted with any trains in the area controlled by the case or signal room.**

18.6 When a ground current reading level is in excess of .025 Ampere (25 mA) on high voltage battery (110 volts) or .001 Ampere (1 mA) on low voltage battery is recorded, further tests must be performed to discover the location of the ground and eliminate it. Record results on test form and record corrective action in the Comments and Corrective Action Section.

NOTE: Where a "battery bus" is energized only by the use of a rectifier/power supply, without including the physical battery, the taking of ground readings on such rectifier/power supply "battery bus" is to be included within the scope of this test. Where rectifier is connected directly to A.C. source such as the switch bridge rectifier test should not be made with ammeter.

CAUTION: IN NO CASE SHALL A CURRENT READING BE TAKEN WHEN A TRAIN IS CLOSELY APPROACHING OR PASSING, NOR SHALL ANY METER CONNECTED BETWEEN ENERGY BUSSES AND GROUNDS BE LEFT UNATTENDED.
AT NO TIME WILL 2 AMMETERS BE CONNECTED TO THE SAME SOURCE WHILE TESTING GROUNDS AS AN AMMETER INDUCES A GROUND TO THE SYSTEM.

CORRECTION OF DEFICIENCIES: Deficiencies identified during ground shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

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MBTA PMP TEST-19 (TEST OF FOULING CIRCUITS AND SHUNT WIRES)

19 MBTA PMP TEST 19 (TEST OF FOULING CIRCUITS AND SHUNT WIRES)

Purpose: To ensure the integrity of the bonding cables in a switch layout and to ensure that the fouling branch of the main track circuit will detect equipment in the foul of the main track.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Results of PMP TEST 19 on fouling circuits and shunt wires shall be recorded on Form MBTA PMP TEST 19. All forms must be sent to the Office of the Deputy Director of Signals.

Results: Any deficiencies noted shall be repaired or corrected immediately. If repairs or corrections cannot be made immediately the Supervisor of Signal Engineering must be notified and arrangements made for safe passage of trains.

Frequency: At least every two years.

Test Equipment: 0.06 Ohm shunt strap, multimeter, and (oscilloscope for AF fouling circuits).

Procedure:

19.1 Record nomenclature of track circuit to be tested in which shunt fouling is applied on Test Form.

19.2 Visually inspect fouling circuit to determine that all c-bonds and foul wires are intact, visible, in good condition, and in place.

For AC track circuits:

19.3 Place a voltmeter across the main track rails, and check for track circuit voltage.

19.4 Place a .06 ohm shunt across the rails at a point within the fouling section farthest from the transposition joints. Check the voltage on meter of the main track rails. Ensure track relay is in de-energized position.

19.5 Move the shunt as close as possible to the transposition joints within the fouling section. Check the voltage on meter of the main track rails. Record P for Passed if track relay is de-energized.

19.6 For shunt fouling circuits within interlockings that have two track relays, perform test with shunt placement at each relay end and ensure both track relays drop to their most restrictive position.

For AF track circuits with shunt fouling:

19.7 Place a .06 ohm shunt across the rails at the point farthest from the main circuit. Verify that the track relay drops.

19.8 If there are two receivers. Verify that the fouling section relay drops when the fouling section is shunted at the receive end and the main relay drops when the main section is shunted at its receive end.

CORRECTION OF DEFICIENCIES: Deficiencies identified during test shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

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Approvals by: Director: Joseph T. McNall

MBTA PMP TEST-20 (TEST OF SWITCH CIRCUIT CONTROLLERS AND POINT DETECTORS)

20 MBTA PMP TEST 20 (TEST OF SWITCH CIRCUIT CONTROLLERS AND POINT DETECTORS)

Purpose: To ensure switch circuit controllers are in good condition and properly adjusted.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Results of PMP TEST 20 shall be recorded on Form MBTA PMP TEST 20. All forms must be sent to the Office of the Deputy Director of Signals.

Results: Any circuit controller or point detector not meeting the conditions of this test must be adjusted, repaired or replaced immediately. If repairs or replacements cannot be made immediately, the Supervisor of Signal Engineering must be notified and arrangements made for the safe passage of trains.

Frequency: At least once every three months.

Test Equipment: Multimeter and switch obstruction tool.

Procedure (All Switches):

20.1 Record the nomenclature of the Switch Circuit Controller and Point Detector to be tested on the Test Form.

20.2 Inspect the general condition of the switch circuit controller, switch point detector, and all connecting rods. Ensure that circuit controller connecting rods, lug and lug connections do not have lost motion and are properly lubricated. Records results as P if OK.

20.3 Inspect all wires to ensure they are properly tagged and clear of all moving parts. Record results as P if OK.

20.4 Check that contacts are clean, bright and uniform. Open contact air gap must not be less than 1/16". Ribbons for contact connections must be in good condition. Record results as P if OK.

20.5 Check that rollers and cams are not worn, cracked or flat spotted. Adjusting screws should be in good condition and must not be stripped or worn. Linkage and roller pins must not be worn excessively and must be in proper position and fastened securely.

20.6 Check the Proper lubrication of switch plates

- Inspect all switch housings for cracks, make sure gaskets are intact, hinges and latches are in good condition and all padlocks are intact and perform their intended function.

- Ensure proper amount of point pressure.
- Check the condition of the lock rod to ensure that the edges are square and the openings conform to safety standards.
- Check locking dog or plunger to ensure that the locking edges are square.

20.7 With switch in normal position, connect a voltmeter across the relay end of the switch repeater circuits to determine if the switch controller is working and NWP circuit is energized.

20.8 Test normal point detector with gauges in accordance with manufacturer's instruction pamphlet so that the switch will latch out with a 3/8" obstruction where mechanical latch out is provided. If switch fails to latch out, point detector needs to be adjusted. Confirm that switch indication contacts are open and voltmeter reads zero. Record results Pass or Fail on test sheet.

20.9 Where mechanical latch out is not provided, normal switch indication contacts must be opened by a ¼" obstruction gauge inserted 6 inches from front of switch point. Float the normal lock-rod (if not 5F wide notch rod) to allow the switch machine to lock when operated against the obstruction. Ensure that locking dog is fully through the lock-rod. Confirm that switch indication contacts are open and voltmeter reads zero. Record results Pass or Fail on test sheet.

20.10 Remove the gauge, close the switch, ensure that the switch repeater circuit closes and the voltage on the switch repeater circuit is there.

20.11 Repeat steps 20.1 through 20.10 for reverse point.

CORRECTION OF DEFICIENCIES: Deficiencies identified during test shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

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Approvals by: Director: Joseph T. McTall

MBTA TEST-23 (NEW INSTALLATIONS, MODIFICATIONS, FALSE PROCEED INVESTIGATIONS)

23 MBTA PMP TEST 23 (NEW INSTALLATIONS, MODIFICATIONS, FALSE PROCEED INVESTIGATIONS)

Purpose:

A. NEW INSTALLATIONS, OF AUTOMATIC SIGNALS AND INTERLOCKINGS - To ensure that new installations of signal systems or modifications to existing signal systems are properly installed and tested.

B. MODIFICATIONS TO EXISTING AUTOMATIC SIGNALS AND INTERLOCKINGS - To ensure that modifications to existing signal systems are properly installed and tested.

C. REPORTED OR SUSPECTED FALSE PROCEED INDICATION OF ANY VITAL SIGNAL SYSTEM - To ensure a complete and accurate investigation is conducted into alleged false proceed signals, or wrong side failures.

Responsibility: Signal Engineer, Signal Inspector, Foreperson, and Wireperson.

Records: Results for MBTA PMP 23 A, B, & C shall be recorded on Form MBTA PMP TEST 23 A, B, & C showing the number of each test performed, the date tested and by whom. The Employee in charge shall sign the forms only after all required tests have been completed. A separate form shall be filled out for each separate test as required by the MBTA SM1.

For Test 23C - False Proceeds: The Supervisor of Engineer & OCC shall complete and submit a false proceed incident report within 7 days of report or incident to the Office of the Deputy Director of Signals for reporting to the MBTA Safety Dept. within 10 days.

Results: All discrepancies must be corrected and adjustments must be made before the facility is placed into service unless authorized by the Supervisor of Signals who must make temporary arrangements for the safe protection of trains. If conditions are observed in which the approved plans do not seem to provide proper protection or flexibility of operation, such conditions shall be immediately protected and brought to the attention of the Supervisor of Signals and Deputy Director of Signals.

Test Equipment:

TEST 23A OPERATIONAL CHECK OF NEW INSTALLATIONS OR MODIFICATIONS TO INTERLOCKINGS, AUTOMATIC SIGNALS AND CAB SIGNAL SPEED COMMANDS.

Purpose: This test ensures that new installations or modifications to existing installations are operating as intended.

Frequency: Before new installations or modifications to existing installations are placed into service.

Procedure 23A:

23.1 A complete operational check to ensure proper switch locking and proper sequence of operations must be made, including:

- Signal aspects
- Speed commands
- Opposing and conflicting signal protection
- Facilities are functioning as intended

23.2 In addition, all applicable MBTA PMP SM-1 tests shall be made on such installations or modifications at this time.

23.3 For each track circuit in cab signal territory or each automatic signal in non cab signal territory verify the entire control line by simulating the movement of a train ahead from one track circuit to the next. Clear and cancel controlled signals ahead as necessary to verify the control line. Record the aspect displayed or cab signal transmitted at each step.

23.4 For each interlocking set up each route and verify the control lines for each interlocking signal and for each track circuit in each route within the interlocking by simulating train movement through each track circuit in advance. Verify that clearing non-conflicting routes does not alter the signal aspect or cab signal display.

23.5 With the original route lined, arrange the signal under test to display "Stop " or "Restricting" (as required by the route being tested) by occupying any portion of the first block beyond the interlocking in the route lined (re-establishing the directional stick if necessary to accomplish this).

23.6 Look at the incoming "H" controls for each <u>other</u> route in the same direction as lined from the signal being tested, to ensure that the receipt of an energized "H" control for any track on these other routes will not cause the signal under test to display a better aspect than intended. The incoming "H" controls may be arranged simultaneously, one by one, or in any combination, but all must be checked against the signal and the route being tested.

23.7 New installations must be given a detailed check promptly upon installation as indicated below in Test 23B. Plans-so-marked must be given a detailed check. All subsequent changes must be checked and plans-so marked must be checked promptly upon completion.

TEST 23B DETAIL CHECK OF LAYOUT, LOCKING AND CIRCUITS

Frequency: Before new installations or modifications to existing installations are placed into service.

Procedure 23B:

23.8 Check layout conditions in the field for agreement with layout plans concerning:

- Track arrangement
- Number, location, frog angle and fouling point of crossovers and turnouts
- Location, type, aspects and routing of signals
- Location of tower, signal housings, buildings, bridges, poles and other structures which affect preview of signals and operation of signal system

23.9 Inspect physical conditions of:

- Tracks and switches
- Signal bridges
- Foundations
- Pipe lines
- Switch Machines
- Tower
- Signal housings and any other buildings involved

23.10 Check signal housings, tower and other buildings for fire hazards.

23.11 Check circuit conditions in the field for agreement with layout plans concerning the condition and location of:

- Insulated joints
- Fouling points
- Fouling wires
- Transposition wires
- Impedance bond connections
- Long wire loop routing
- Cab Signal Loops
- Batteries and chargers
- Relay connections and locations
- Wires and cables
- Switch circuit controllers and rods
- Transformers
- POWER switch movements
- Electric switch locks
- All other apparatus on or about the tracks

23.12 Each relay (or other signal apparatus) location must be inspected to ensure:

- Location contains all the apparatus called for on plans and that there is no excess apparatus or foreign material.

- Apparatus is of proper type and has proper inspection dates.
- Power and battery supplies are provided, and fused and designated according to plan.
- All index plates on bases and plug-in relays must be checked to ensure that the prescribed pins and holes for each relay are properly installed and secured.

23.13 Check must be made of the number in use, kind, condition and adjustment of contacts in relays, electric locks, circuit controllers, releases, and similar devices, and tagging wire nomenclature of wires to controls and contacts.

23.14 Test must be made of all circuits to ensure that the opening of each contact in the control circuit cuts off the control current under conditions shown on plan, following through all multiple circuits and cut-around (wrap around circuits). When a circuit is broken over a relay twice, or when it is broken over some other contact that will be opened by opening the relay, the wires in the circuit must be disconnected for test in addition to the opening of the relay.

23.15 Conditions found that are not in accordance with approved plans shall be corrected at once, or steps shall be taken to revise the plans to agree with the work.

23.16 All EPROM's containing vital signal logic must be verified with approved plan for each specific item of equipment at each location. This verification must include all information on Signal plans and EPROM label. This is described in the Software Management Control Plan (SMCP).

Vital & Non Vital Software:

23.17 When any vital or non-vital software is changed all vital software changes to the program shall be shown in the VMIS Validation Report, VMIS Revision History Log, Colored Red and Green Equation Printout and the MBTA Signal Department SMCP. All software affected by the changes shall be tested as described by the Supervisor of Engineers or his/her designee. For non vital software, changes will be tested the same way without the validation report and reported on Test 23 report form. The colored printout will show all the changes made to the equations from within the program to be changed as Yellow = To Be Removed and Red = To Be Installed. Tests should be completed to prove changes and proper operation of functions that are associated with these changes. In addition it may be necessary to perform a functional test of the system to ensure signals, switches and other appliances operate as designed.

23.18 A copy of all tests on software changes performed shall be sent to the Supervisor of Engineers for compliance with 49CFR 236 Subpart H and the MBTA SMCP. All old EPROM software shall be returned to the Signal Design Office after all tests are performed and in compliance with the plans and software documentation.

23.19 Disarrangement of Signal Software – due to a catastrophic failure of the operating or executive software caused by electrical surges, lightning strikes, fire, vandalism or other reasons shall prompt a complete operational test using an exact duplicate of the existing software.

23.20 Once a contractor has designed a Vital Signal Logic system and it's installed and placed in service with a revision level of "N/C" as per MBTA's SMCP, all future contractor changes will be submitted to the MBTA's Signal Design Office, for approval prior to any software being put in service.

23.21 Revision updates of Executive Software will be determined by MBTA's E&M Letters on the manufacturers Product Improvement Announcements (PIA) and their Engineering Service Bulletins (ESB). Testing of this software, when installed in equipment that is already in service will consist of an operational test and watching train movement in both directions.

23.22 When any vital software is changed all changes to the program as detailed in the Validation Report shall be tested as described by the Supervisor of Engineers or his/her designee. In addition it may be necessary to perform a functional test of the system to ensure signals, switches and other appliances operate as designed.

23.23 A copy of all tests performed shall be sent to the Supervisor of Engineers for compliance with 49CFR 236 Subpart H.

23.24 The Test Inspector shall submit the sign off sheet (SDP-1021-3) detailing what software revision was removed, what revision was installed and other relevant information to the Office of the Supervisor of Engineers for compliance with 49CFR 236 Subpart H.

23.25 Inspect signal cases and housing to ensure all excess material has been disposed of and the installation renders a neat and orderly appearance. **Inspect the plans and software documentation so that it agrees with the field conditions.** When making these checks and tests, if conditions are observed in which the approved plans do not seem to provide proper protection or flexibility of operation such conditions shall be immediately protected and reported to Supervisor of Signals and Deputy Director of Signals.

TEST 23C FALSE PROCEED INVESTIGATIONS

Frequency: Upon receipt of a reported false proceed, Signal Supervisior must be notified immediately and steps taken to download event recorders and play back movements on OCC computers.

Procedure 23C:

23.26 When the signal system is reported or suspected to have given False Proceed information, the system shall be given a complete operational check to ensure proper switch locking and proper sequence of operations including:

- Signal aspects
- Cab Speed Commands
- Opposing and conflicting signal protection and overrun protection

23.27 It must be ensured that facilities are functioning as intended. **(Verify sequence of events through recording devices where available).**

23.28 If the False Proceed, or reported False Proceed cannot be duplicated and verified as to the cause, then a 24-hour signal watch is to be established, verifying all signal aspects, cab signal commands, and switch positions in the route involved. All aspects shall be recorded for each train movement and each change in aspect by the employee in charge.

23.29 In addition, all applicable E&M PMP tests shall be made on such installations as follows:

- PMP TEST 2, Insulation Resistance
- PMP TEST 4, Relays and other Electromagnetic Apparatus to ensure that relays are within specification and are according to approved plan
- PMP TEST 18, Test of Grounds
- PMP TEST 23B, Detail Check of Layout, Locking and Circuits
- PMP TESTS 24, 25 and 26 Track Circuits

23.30 Depending on conditions and circumstances, the following tests may be required:

- PMP TEST 9, Test of Time Locking
- PMP TEST 10, Timing Devices
- PMP TEST 11, Test of Switch Indication Locking
- PMP TEST 13, Test of Switch Obstruction
- PMP TEST 15, Test of Route Locking
- PMP TEST 16, Test of Traffic Locking
- PMP TEST 19, Test of Fouling Circuits and Shunt Wires
- PMP TEST 20, Test of Switch Circuit Controllers and Point Detectors
- PMP TEST 27, Test of Insulated Rail Joints

23.31 The Deputy Director of Signals shall record and provide the following:

- False Proceed Investigations Report Form.

- Electronically recorded event data shall be transferred and maintained in electronic and written format.
- Reporting Motor person Interview Report Form.

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Approvals by: Director: Joseph T. McNally

MBTA PMP TEST-24 (TEST OF AC TRACK CIRCUITS)

24 MBTA PMP TEST (TEST OF AC TRACK CIRCUITS)

Purpose:

- To ensure track relays and track receiver units are not over energized.
- To ensure that track relays, and devices that function as track relays are in their most restrictive state when occupied.
- To ensure that the track circuit polarity is in accordance with the plans and to maximize protection against defective insulated joints isolating adjacent track circuits.
- To ensure that all track circuit wire connections are properly secured and tight, insulated joints are in good condition and arresters and protectors in good condition.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: Results of MBTA PMP Test 24 for track input voltage shall be recorded on Form MBTA PMP Test 24, with the track circuit nomenclature and all appropriate readings. Copy of test form to be left in the house or case location and original forwarded to the Office of the Deputy Director of Signals.

Results: Any track circuit failing to meet the requirements of the above tests shall be repaired or corrected immediately. If discrepancies cannot be immediately rectified, then the Supervisor of Signal Engineering must be notified and arrangements must be made for the safe passage of trains.

Frequency: At least once every 2 years.

Test Equipment: Multimeter and Shunt Strap.

Procedure:

24.1 Record the name of the track circuit tested.

24.2 Record the relay type (AC Vane, SE3, etc.).

24.3 Record the tag information D.A (Dropaway), P.U. (Pickup), and W.C. (Working Current).

24.4 Walk the track and inspect all bonding, insulated joints and track connections. Make repairs as required. Inspect track circuit lightning arresters and surge protectors to ensure that they are intact and have not been damaged by lightning, power surge or

traction. Replace any arresters or surge protectors which appear to have been damaged. *Visual insulation test.* All Track Insulation must be visually inspected. If inspection indicates poor conditions of insulation, test shall be made in accordance with Test 27. Insulated joints **MUST** also be inspected for spikes, rail anchors, tie plates, rail flow, end post missing and any condition that would bridge the insulation of the joint. In addition, switches **MUST be** inspected for rod clearances that would bridge the insulation and affect the integrity of the track circuit.

24.5 Connect the multi-meter (set to read AC Amperage) in series with the track relay's coil. Record current on Test Form.

24.6 Test for shunting sensitivity at transformer and relay ends by observing the current reading with a .06 ohm shunt strap connected to each end of the track circuit tested. Record current on Test Form.

24.7 Verify that the track relay drops to the back stop. Record results on Test Form.

24.8 If the relay drops to the back stop and the current meets the requirements for working current proceed to polarity check in 24.13.

24.9 For Safetran Phase Selective track circuits with DC relays verify that the DC relay drops when the shunt is placed at transformer and relay ends.

- Measure RB-RN DC relay coil voltage with the track circuit not shunted and then again with the track circuit shunted. Record the results.

24.10 If relay current reading (relay voltage reading for SE3 circuits) is above the drop away value of the track relay with a shunt strap connected to the track, immediate corrective action is required.

24.11 If track circuit fails to meet minimum requirements correct the cause and adjust the working current and proceed to the steps below:

- Read and record transformer AC output voltage.
- Read and record transformer end AC current (at fuse clip).
- Read and record transformer end resistor setting.
- Read and record transformer end TB-TN AC voltage.
- Read and Record AC voltage at rail to rail at the transformer end.
- Read and Record Rail to Rail AC voltage at the relay end.
- Read and Record AC voltage at RB-RN.
- Read and record Relay end current through the relay coil.
- Read and record local coil voltage (dual element vane relays).
- Disconnect a wire from the relay end resistor and measure and record relay end resistance.

24.12 First at the Relay end of the track circuit place a shunt around the insulated joint(s).

- Verify that the track relay drops.

24.13 Repeat 24.13 at the transformer end to the track circuit.

- Verify that the track relay drops.

24.14 Conditions accountable to the E&M Signal Division that would affect the integrity of the track circuit **MUST** be corrected immediately. All other conditions **MUST** be reported to the immediate Supervisor of the responsible department for correction.

CORRECTION OF DEFICIENCIES: Deficiencies identified during test shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

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Approvals by: Director: Joseph T. McNall

MBTA PMP TEST-25 (AF TRACK CIRCUIT PARASITIC OSCILLATION AND LEVEL TEST)

25 MBTA PMP TEST 25 AF TRACK CIRCUIT PARASITC OSCILLATION AND LEVEL TESTS

Purpose: The purpose of this test is to:

- Verify that there has been no change in the health and levels of the track circuit.
- That the ferrite cores installed to prevent harmful parasitic oscillations are present.
- That no harmful parasitic oscillations are travelling between track modules.
- Verify that the track circuit properly shunts while a train is in the circuit.

Responsibility: Signal Engineer, Signal Inspector, Foreperson, and Wireperson.

Records: The Results of MBTA PMP TEST 25 shall be recorded on MBTA PMP TEST 25 Form along with the track circuit number, location of the transmit and receive modules, ferrite core status, entrance rack terminals, and all required voltage levels and waveform types. A copy of the Test form shall be kept in the Signal Room and the original forwarded to the Deputy Director of Signals.

Results: Track circuits with missing ferrite cores and displaying type 4 parasitic oscillations shall be immediately repaired. If problems cannot be repaired then the track circuit shall be taken out of service until such repairs can be made. Any track circuit with missing ferrite core but no parasitic oscillations shall be repaired within 5 days. Any track circuits displaying track levels that deviate more than 15% from the recorded levels on the room master sheet shall be investigated and repaired according to the troubleshooting manual.

Frequency: Annually.

Test Equipment: 200 MHz bandwidth Oscilloscope, 100 ohm resistor, and clip leads.

Procedure:

Level and Parasitic Oscillation Test

Ferrite Core Inspection

25.1 Visually inspect the back of the transmit and the receive modules for presence of a ferrite core around the B28 power leads. All generation 2, 3, 4 and 5 modules must have a ferrite core tightly secured around the B28 power leads.

Parasitic Oscillation Check

25.2 Verify the track circuit frequency by reading frequency at Amp-in on the receiver

25.3 Parasitic Oscillation tests should be taken on the transmit end module of the track circuit under test. Insert the test leads of a 200 MHz bandwidth oscilloscope into the input and common test jacks on the front of the Gen 2, 3, and 4 modules. On Generation 5 modules, the readings are taken at Amp in (TP4) and Common (TP5) on the power amplifier board. Turn track module under test to steady track.

25.4 Record peak to peak voltage on the Test Form.

25.5 Observe the waveform and classify according to MBTA AF Track Circuit Trouble Shooting Manual. Record oscillation type.

25.6 If a type 4 oscillation is observed, trace the source of the oscillation by turning off track modules one at a time until the oscillation disappears. Tighten or replace the ferrite cores on the modules involved as necessary to eliminate the oscillation.

25.7 If the type 4 oscillation cannot be eliminated, the track circuit must be immediately taken out of service. Notify the Supervisor of Signals immediately.

Track Circuit Level Readings

25.8 Walk all track circuits to be tested.

- Record the milepost locations of all missing or badly frayed C bonds, any loose bonding at transposition joints or WeeZ bonds, or any missing or disconnected bonding between guard rails and running rails. This must be done within 30 days prior to testing.
- Inform the Line Supervisor of all missing or damaged bonding and the locations. Make sure that all broken or missing bond connections are repaired before continuing test.

25.9 Using the oscilloscope read and record the following:

- Receiver Amplifier input.
- Receiver Amplifier input with 100 ohm Resistor placed across the Bond Line either at Line+/Line - or at the Entrance Rack. (This step may be skipped for untuned Receive/Receive bonds in Red Line and Southwest Corridor interlockings.)
  - ➢ The ratio of the two readings indicates the health of the Receive end WeeZ bond.
- Transmitter output at Line+/Line.
- Transmitter output at Line+/Line- with 100 ohm resistor across Line +/-.
  - ➢ The ratio of the two readings indicates the health of the Transmit end WeeZ bond.
- For tuned loop transmitters used on the Orange Line Haymarket North Section read and record Line+/- with the entrance rack links closed and again with the links open.
  - ➢ The reading should be higher with the links open.

- Observe Amp Out on the receiver board with the test switch in the normal position while a train goes through the track circuit. The signal will decrease as the train approaches the entering WeeZ bond and increase as the rear of the train passes the transmit bond. In between the Amp Out level should not exceed 4 volts peak to peak.

  Note 1: Transients of less than 1 second duration may exceed the 4 volt limit.

  Note 2: Where Dual Code rate receiver boards are used, Amp Out levels as high as 6 volts peak to peak are acceptable when the interfering signal is of a different code rate than the receiver board.

- Record Amp-Out with the test switch down and no train in the circuit. This reading should be taken by counting the divisions on the oscilloscope rather than the digital read out.

CORRECTION OF DEFICIENCIES: Any track circuit displaying track levels that deviate more than 15% from the recorded levels on the room master sheet or the previous level test shall be investigated and repaired according to the AF Track Circuit Trouble Shooting Manual. Any track circuit displaying type 4 oscillations or any track circuit that displays excessive Amp Out voltage with a train in the circuit that cannot be immediately repaired shall be removed from service. The Supervisor of Signal Engineering shall be immediately notified and arrangements shall be made for safe passage of trains.

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MBTA PMP TEST-26 (AF TRACK CIRCUIT SHUNT AND GROUND TEST)

26 MBTA PMP TEST 26 (AF TRACK CIRCUIT SHUNT AND GROUND TEST)

Purpose: The purpose of the shunt test is to verify that the track circuit shunts at both ends and the middle and that there are no harmful levels of cross talk or parasitic oscillations affecting track circuit shunting.

Responsibility: Signal Inspector, Foreperson, and Wireperson.

Records: The results of MBTA PMP Test 26 shall be recorded on MBTA PMP TEST Form 26. All voltage, required voltage levels and Pass/Fail test results shall be recorded for each track circuit. Copies of the test form shall be kept by the Signal Room and by the Line Supervisor. The original shall be submitted to the Deputy Director of Signals.

Results: Track circuits which fail the shunt tests or the dead short shunt tests shall be immediately investigated using the MBTA AF Track Circuit Troubleshooting Manual. The track circuit shall be repaired as necessary. If the track circuit cannot be repaired before revenue service it shall be removed from service until repairs are made. Arrangements shall be made for safe passage of trains **until repairs are made. The Supervisor of Signal Engineering** shall be notified.

Frequency: Bi-Annually.

Test Equipment: Oscilloscope and shunt straps of values listed in Table 1.

Procedure:

Check Levels

26.1 Record Amp-in at the Receive Module and Line+/- at the Transmit Module. If Amp in is not between 1.5 vpp and 3.5 vpp on the Red Line or between 2.5 vpp and 3.5 vpp on the Orange Line investigate the cause. If no problems are found, adjust the transmit power level to bring Amp in within the acceptable range. For High Definition Loops, Amp-in ranges from 1.1 vpp to 9 vpp are acceptable.

Bond Line Ground Check

26.2 At the entrance Rack read and record the peak to peak voltage to ground from each terminal of the transmit and receive bond lines. Record the maximum value presented with the track circuit unoccupied.

26.3 If one side to ground is more than 20% larger than the other, a ground may be indicated on the lower side.

26.4 If the difference is greater than 20%, open the links. If the difference is reduced the problem is in the field otherwise it is in the room.

- If the problem is in the room, megger from the entrance rack back into the module with the links open on the 500 volt scale. If the circuit tests greater than 2 meg-ohms to ground then the problem is capacitance in the module and can be ignored.
- If the problem is in the field, megger between junction boxes to isolate the ground. Repair or replace the bad section of cable.

Shunt Tests

26.5 Track circuits must successfully shunt with the shunt listed in Table 1 below. The track relay must drop when the circuit is shunted over each bond and when it is shunted in the middle.

26.6 Track circuits that are adjusted to 2x pickup according to Table 1 should be so adjusted before shunting.

Note 1: Red Line bond to bond track circuits within 90 feet of a station may be adjusted against a shunt rather than 2x pickup. With Engineering approval a 0.06 ohm shunt may be used. The receiver modules of track circuits so adjusted must be tagged with the shunt used and for 0.06 ohm shunts the name of the approving Engineer.

26.7 For all track circuits, record the amp in level with the shunt over the receive bond.

26.8 Track circuits that are adjusted against the shunt should be adjusted to just drop at the receive end with the shunt applied before proceeding to other locations.

- Occasionally the gain must be further reduced to pass the shunt test on the transmit end. In this case, the Amp-In Level must then be recorded with the shunt over the transmit bond.

26.9 Verify that the track relay drops with the shunt in each of the 3 locations.

- For track circuits with a 4 or 2 foot loop transmitter, the transmit end should be shunted 4 feet in from the edge of the transmit loop that is closest to the receiver.

Table 1 ADJUSTMENT AND SHUNT OF AF TRACK CIRCUITS

Track Circuit Type	Adjustment	Shunt	Shunt Test
Red Line Bond to Bond	2 x pu	.15 Ω	Shunt both end and middle plus dead short shunt
Red Line Track circuits with bonds within 90 feet of a Station	2x pu or to shunt (see Note 1)	See Note 1	Shunt both ends and middle plus dead short shunt test
Orange Line Bond to Bond	To just drop with a 0.18 ohm shunt over receive bond	.18 Ω	Shunt at Receive bond, middle and transmit bond
Red Line and Southwest Corridor Interlockings	Adjust to drop with .06 Ω shunt	0.06 Ω	Shunt over both bonds and the middle plus dead short shunt test.
Orange Line Haymarket North Interlockings	Adjust to drop with a shunt at receive/receive bond	0.06 Ω	Shunt over both bonds and the middle plus dead short shunt test.
High Definition Loop	Does not drop with dead short shunt on side away from transmitter. Drops with a resistor shunt on the edge toward the transmitter.	0.15 Ω Red 0.18 Ω Orange	Shunt at loop, in middle and at transmitter, plus the dead short shunt test.
Orange Line Voltage RJ	Adjust to drop with shunt over RJ track connections except at Essex where 2x pu is used	0.18 Ω	Shunt at RJ and transmitter + dead short shunt test

Dead Short Shunt Test

26.10 Place two dead short shunts in the middle of the track circuit. Where restraining rail is present, the shunts should be placed at locations where they are close to the

points where the restraining rail is bonded to the running rail and the balancing cable is attached to the running rail.

26.11 Read and record Amp-Out with the test switch ***up*** on the receiver module. The level should be less than 4 volts peak to peak.

- Levels greater than 4 volts peak to peak are a serious safety issue and must be immediately investigated. Refer to the Troubleshooting Manual for troubleshooting procedures.
- For dual code track circuits levels as high as 6 vpp of a different code rate from the track circuit may be accepted.

26.12 If the cause of the high levels under the double short shunt test cannot be corrected before revenue service :

- If the level is less than 8 vpp, reduce the gain on the receiver until the level is less than 4 vpp. The cause of the high levels must be repaired as soon as possible.

26.13 If the Amp-Out level observed is greater than 8 vpp, the track circuit must be removed from service immediately. The Line Supervisor and Deputy Director of Signals must be notified.

26.14 When the track circuit passes all tests, record Amp-Out on the receiver board with the test switch down. Readings should be taken by counting divisions on the scope screen.

CORRECTION OF DEFICIENCIES: All deficiencies must be recorded, investigated and corrected according to the MBTA AF Track Circuit Troubleshooting Manual. All failures of shunt or dead short shunt tests which cannot be immediately must be reported to the Line Supervisor and the Supervisor of Signal Engineering and provisions must be made for safe passage of train.

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Approvals by: Director: Joseph C. McNall

MBTA PMP TEST-27 (TEST OF INSULATING RAIL JOINTS AND SWITCH INSULATION)

27 MBTA PMP TEST 27 (TEST OF INSULATING RAIL JOINTS AND SWITCH INSULATION)

Purpose: Test is to determine if the protective apparatus installed is operative and in good condition.

Responsibility: Signal Inspector and Wireperson.

Records: Results of PMP Test 27 shall be recorded on Form MBTA PMP TEST 27.

Results: Indication of any poor insulation must be tested. If the insulation is found to be defective report the defect to the Supervisor of Signal Engineering and promptly replace.

Frequency: At least once every two years.

Test Equipment: Track Insulation Test Unit.

Procedure:

27.1 Record location of Insulated joints to be tested (e.g. 236 RN/238 TB) on Test Form.

27.2 Using the approved standard track insulation test unit and following the Manufacturer's recommended instruction test each insulated joint at the location and record results (Pass/Fail).

27.3 Record Switch Number of switch insulations joints to be tested (i.e. 27-1A SW) on Test Form.

27.4 Using the approved standard track insulation test unit and following the Manufacturer's recommended instruction, test all switch rod, gauge rod and gauge plate insulations at the location and record results (Pass/Fail).

CORRECTION OF DEFICIENCIES: Deficiencies identified during test shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

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MBTA PMP TEST-28 (TRACK MAPPING)

28 MBTA PMP TEST 28 (TRACK MAPPING)

Purpose: The purpose of this test and follow up procedure is to detect and correct:

- Track circuit that are pre-shunting too early or too late indicate over driven circuits or failed bonds.
- Detect and correct incorrect cab signal levels.
- Detect and correct missing DC return bonding and potential broken rails.
- Detect and correct failed insulated joints.

Responsibility: Signal Engineer and Signal Inspector.

Records: The Engineer performing the track mapping shall produce a report including analysis of each deficiency, a snapshot of the relevant area of the mapping, and relevant control lines. The report shall be submitted to the Line Supervisor, Line Inspector and the Deputy Director of Signals. The Line Inspector or Wirepersons correcting the deficiencies shall describe corrective actions taken on the MBTA PMP Form 28 attached to the report.

Results: All deficiencies detected must be analyzed, and corrected within 20 days of the date of the track mapping.

Frequency: Monthly.

Test Equipment: Analog to Digital Converter and MBTA Labview Track Mapping VI.

Procedure:

28.1 The test equipment shall be set up to read either the raw input to the ATP controller from the pickup coils of the lead car or the output of the Test Coil if a test coil is available.

28.2 The Signal Engineer shall select the line and direction of travel in the track mapping application as well as the date of the track mapping in order to ensure the recording of the date, line and direction in the data file is correct.

28.3 The Signal Engineer shall use the track mapping software to mark the entry into each station.

28.4 During playback of the recorded track mapping the Signal Engineer shall take snapshots of each deficiency and analyze the cause using the MBTA Track Mapping Guidelines as a reference. Particular attention should be paid to the following:

- Excessive cab signal level at the entrance to a track circuit indicating danger of bleed over to other circuits.
- Excessive gaps in cab signal at the start of a track circuit indicating an over driven train detection portion of the track circuit.
- Cab signal starting before the track signal indicating a deteriorated bond, or partial fouling of a track circuit.
- Dips in cab signal and track signal level within a track circuit indicating a DC imbalance caused by bonding off or cracked rail.
- A fluctuating cab signal code rate within a track circuit indicating a bobbing track circuit ahead. Refer to control lines to determine which circuit.
- Presence of an interlocking frequency or conflicting code rate in the approach track circuit indicating a failed Insulated Joint.

28.5 The Signal Engineer shall use the station markings and track circuit frequencies to determine the exact track circuit where the deficiency is observed. The Signal Engineer shall include in the Track Mapping Report an analysis of each deficiency, control lines or other data that may be useful in trouble shooting the problem.

28.6 The Line Supervisor, Line Inspector and Wirepersons shall investigate and correct all deficiencies listed in the Track Mapping Report using the MBTA Audio Frequency Track Circuit Basic Troubleshooting Procedures as a guide. All investigation findings, corrective actions taken and post corrective action tests performed shall be recorded in MBTA PMP Form 28 and returned to the Signal Engineer within 20 days.

28.7 The Signal Engineer shall keep a copy of each Track Mapping report and returned PMP 28 Form and shall submit an additional copy to the Deputy Director of Signals.

CORRECTION OF DEFICIENCIES: Deficiencies identified in the Track Mapping Report shall be corrected in accordance with MBTA Audio Frequency Track Circuit Basic Troubleshooting Procedures. In the case of detection of a false permissive cab signal command, the track circuit shall be immediately removed from service, the Supervisor of Signal Engineering notified and arrangements made for safe passage of trains.

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MBTA PMP TEST-39 (RECORDING DEVICES)

39 MBTA PMP TEST 39 (RECORDING DEVICES)

Purpose: Test is to ensure that interlocking and other recording devices are functioning as intended for time, date, accuracy and information. Tests should be done for all recorders, including but not limited to, Microloks, VPI's, Event Recorders, NVLPC recorders.

Responsibility: Signal Engineer.

Records: Results of PMP Test 39 shall be recorded on Form MBTA PMP TEST 39.

Results: If any part of Test 39 fails to pass the test, corrective action must be promptly taken.

Frequency: At least once each year.

Test Equipment: Laptop computer with recorder or processor interface software.

Procedure: **TIME AND DATE VERIFICATION**

39.1 Access each recorder at the location or via modem or network. (If so equipped).

39.2 Ensure that the time and the date are correct.

39.3 If multiple recorders are used, ensure that they are synchronized.

39.4 Record several events on both present and past information, insuring that information is without error.

39.5 If device is sending an alarm, verify that proper sending and receiving information is working as intended.

CORRECTION OF DEFICIENCIES: Deficiencies identified during test shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

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Approvals by: Director: Joseph T. McNulty

MBTA PMP TEST-40 (SOFTWARE MANAGEMENT AND CONTROL PLAN)

40 MBTA PMP TEST 40 (SOFTWARE MANAGEMENT CONTROL PLAN)

Purpose: ***Test is to*** audit the software management procedures.

Responsibility: Signal Engineer.

Records: Results of PMP TEST 40 shall be recorded on Form MBTA PMP TEST 40. All work and test data must be logged on the test form in duplicate with one copy being forwarded to the Supervisor of Signal Engineering and the other copy staying at the location.

Results: If any part of Test 40 fails to pass the test, immediate corrective action must be taken and Supervisor of Engineers and OCC must be notified.

Frequency: Each location in the database must be audited at least once every year in accordance with the SMCP policy.

Test Equipment: Laptop computer with appropriate interface software installed.

Procedure:

40.1 Signal Engineers that are required to perform an audit will need to access and print copies of the software and hardware databases and the SMCP Audit Documentation Forms. A copy of the Cad Drawings and Application Notes Documentation should be at each location.

40.2 Once this is done, proceed to the audit location and verify the field parameter settings against the databases by checking off the items on the Audit Documentation form. Verify Software by comparing the Cad Drawing name of the EPROM with the field and then match that with the database and check sums. If this Audit passes, then send the documentation to Signal Design.

40.3 If corrective actions are needed, fill out the bottom of the form and send it to Signal Design.

40.4 After any corrective actions are completed the same form will be dated and copies will be sent to the Supervisor of Engineers and OCC for record keeping.

40.5 If the field needs corrected documents or printed circuit boards updated, that material will be sent by the proper personnel.

CORRECTION OF DEFICIENCIES: Deficiencies identified during test shall be documented on test form and corrected in accordance with OEM and/or MBTA requirements. Immediately notify OCC, the Supervisor of Signal Engineering and make arrangements for safe passage of trains.

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