THE PENNSYLVANIA RAILROAD

LOCOMOTIVE MAINTENANCE INSTRUCTIONS NO. L-44-A

ISSUED PHILADELPHIA, PA.
JUNE 25, 1943

Code System of Continuous Automatic Four Indication Cab Signals with Whistle and Acknowledger—Operation, Tests and Maintenance

(Superseding Locomotive Maintenance Instructions L-44, dated February 1, 1930.)

GENERAL

1. This cab signal device is known as the Code System of continuous automatic cab signals with whistle, and acknowledger, and is manufactured by the Union Switch and Signal Company. The purpose of this equipment, is to provide a continuous cab signal indication, together with means for automatically sounding a warning whistle after a more restrictive cab indication is given, as well as means for suppressing the sounding of the warning whistle.

2. The following rules and instructions for the operation, care and maintenance shall be carefully read by all employees whose duties require them to operate locomotives so equipped, or to maintain this equipment. In case any of the instructions are not thoroughly understood by an employee, he shall request information from his immediate superior, in order that all points may be clearly comprehended by him.

3. Equipment described herein is commonly referred to as “Plug-in, New York Div. Type.”

DESCRIPTION

1. Engine Equipment:

A receiving bar, with its coils, is mounted on the locomotive just ahead of the leading pair of wheels, and so located as to have a clearance of from 6½" to 9½" between the bottom of the bar and the top of the rail. It provides the means of receiving alternating current energy from the rails for energizing the cab signal equipment, thus controlling its functions.

An equipment box mounted on the locomotive houses a vacuum tube amplifier with master relay, decoder, decoding relays and acknowledging stick relays. A main switch is mounted at one end of the equipment box on the outside and a terminal box at the other end, Fig. 1.

Cab signals of the position light type are located on both the engineman’s and fireman’s side of engine cab and display four signals as follows:

Clear — Approach Medium — Approach — Restricting

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An acknowledging switch by which sounding of warning whistle may be suppressed, is located in the cab on the right side, and convenient for engineman to operate.

A magnet valve, Fig. 2, which interlocks signal control with the warning whistle, is located on the power reverse gear bracket.

A warning whistle, connected to the magnet valve, gives a continuous sound after a change to a more restrictive cab signal, which sound can be suppressed only by operation of the acknowledging switch, unless the cab signal has changed to clear.

The headlight generator furnishes the direct current power supply.

2. Non-automatic Territory:

A train can run from automatic cab signal territory into non-automatic cab signal territory by acknowledging the transition. On entering automatic cab signal territory, the device will be automatically cut into service at the first energized cab signal track circuit.

3. Wayside Equipment:

The wayside equipment is designed to operate on 100 cycle alternating current, with wayside signals and adequate automatic switching equipment controlling standby power at various locations, to insure a reliable power supply at all times. In certain areas in and around New York, where both d.c. and a.c. traction current is used, the signalling current is 91.6 cycles. A number of amplifiers has been modified to operate on 91.6-100 cycles. The master relay on the locomotive is controlled by energy from the track circuit in which a code transmitter at the exit end of the block is connected. Whenever a train is in the block, the track relay opens and the track current is then interrupted by means of the code transmitter, the prescribed number of times per minute depending upon the conditions of the trackway in advance. This coded current, in turn, is transmitted to the master relay aboard the locomotive, which selects the proper decoding relays and through a series of contacts controls the cab signal indications and magnet valve. The codes used in this system display signals as follows:

- Clear ..................... 180 Interruptions per minute
- Approach medium .......... 120 Interruptions per minute
- Approach ....................... 80 interruptions per minute
- Restricting ...................... Steady current, or absence of current.

4. General Description:

The principal of induction is used in transmitting the energy from the rails to the locomotive equipment. This is accomplished with the receiver bar, mounted on the locomotive just ahead of the leading pair of wheels. The receiver bar consists of a laminated iron core, on which are mounted coil windings in suitable housings. The action between the rails and the receiver bar may be thought of as a transformer, in which the rails act as the primary and the coil windings as the secondary.

The energy induced in the receiver bar is amplified and then passed through the master transformer, to operate the master relay. The current for the cab signal lights, filaments of the vacuum tubes and the decoding relays and acknowledging stick relays is taken from the headlight generator at 32 volts. The current for the plate circuits of the vacuum tubes is taken from the dynamotor or the dual voltage headlight generator at 350 volts.

The method of interlocking the electrical equipment with the pneumatic warning whistle, is by selecting the control of the magnet valve through contacts of the direct current relays, as described later.
5. Description of Locomotive Circuits:

Standard tracing D-407351, Fig. 3, is a diagram of the locomotive circuits and apparatus, all being shown with a clear cab signal.

The receiver bar, with its coils, constitutes the core and the secondary of a transformer, of which the rails are the primary, so, when alternating current flows in the rails, a voltage is induced in the receiver bar coils above them. The receiver coils are so connected that the voltage induced by the current flowing in the opposite directions in the two rails is additive. The receiver, tuning condenser, and primary of the filter are connected in series, and this circuit is tuned for resonance at the operating frequency. One lead of the filter secondary is connected to the grid of the first stage tube and the other lead to the common wire “C”, with a condenser in parallel. This portion of the circuit is, likewise, tuned at operating frequency. The purpose of the filter is to choke out all other frequencies. The coded voltage induced in the receiver coils is amplified and converted to low frequency current to control the master relay. The master relay is a direct current polarized relay and repeats the code as furnished by the wayside code transmitter. Normally, headlight generator current flows from B-32 to the master relay contacts, contacts of the “A” and “RP” relays, the pilotron tube filament circuit and returns over the “C” wire.

The master relay is operated by the increase and decrease of the plate current from the amplifying tube. This change of plate current is caused by the interrupted current, which is induced in the receiver coils and in turn is applied to the grid. The plate current is at a minimum value when no voltage is being induced in the receiver coils, and at a maximum value when voltage is induced. As the clear signal is received when the track current is interrupted 180 times per minute, this means that track current is off and on 180 times and, consequently, the plate current decreases and increases 180 times per minute. Each time the plate current is decreased, the current in the secondary of the master transformer flows in one direction, and when the plate current is increased, the secondary current of the transformer flows in the opposite direction. The flow of the induced current in the secondary of the master transformer reverses coincident with the increase and decrease of current in the primary and actuates the master relay contacts. The operation of the master relay contacts connects 32 volt direct current alternately to one end or the other of the primary of the decoding transformer, inducing code frequency alternating current in the secondary. Selective operation of the three decoding relays is accomplished by an arrangement of selective circuits so that the “A” relay will be picked up only when 180 interruptions per minute are received, and so that the “R” relay will be picked up only when 120 interruptions are received, and so that the “L” relay will be picked up when 80 interruptions are received. Due to the fact that the “L” relay circuit is not tuned, the “L” relay will be energized for all code interruptions. This selection is accomplished by a resonant circuit for the “A” relay, comprising a reactor and condenser tuned to 180 interruptions and connected across the terminals of the decoding transformer secondary. The reactor is used as a step down transformer, the rectifier connected to the “A” relay being connected to a low voltage tap on the reactor winding. By this means, sufficient current to pick up the “A” relay will be flowing in the “A” resonant circuit only when the code frequency is approximately 180 interruptions per minute. Similarly, the “R” relay is energized through a resonant circuit, comprising a reactor and condenser, tuned to respond to approximately 120 interruptions per minute only, connected in parallel with the “A” circuit across the decoding transformer. The circuit for the “L” relay is not tuned, but the “L” rectifier is connected to the decoding transformer directly with a reactor in series to cut down the current flow through the “L” circuit at the higher code frequencies. Fig. 3.

When the 180 code is in effect, the master relay will make 180 operations per minute and the “A”, “R” and “L” decoding relays will assume the positions as shown in Fig. 3. Current supplied by the headlight generator will then flow through wire B-32 to No. 1 contact finger of “A” decoding relay, wire A lighting clear cab signal, returning over wire NA, No. 2 contact finger of “A” decoding relay to wire C. A tap from wire “A” to contact of RP acknowledging relay through No. 2 contact finger, wire H1 through bottom contact of acknowledging switch, wire H to magnet valve, wire NH to No. 3 contact finger of RP acknowledging stick relay, wire NA and back to wire C. Fig. 3.

When the 120 code is in effect in the rails, the master relay will make 120 operations per minute and the “R” and “L” decoding relays will be energized and the “A” decoding relay be de-ener-
gized, and its contact fingers assume the down position. Current will, then, flow from wire B-32 to No. 1 contact finger of “A” decoding relay, wire A1 to No. 1 contact finger of “R” decoding relay, wire R lighting the approach-medium cab signal, returning over wire NR to No. 2 contact finger of “R” decoding relay, wire NA1 to No. 2 contact finger of “A” decoding relay and back to wire C.

Acknowledgment having been made, acknowledging stick relay RP will become energized and the contact fingers will assume the up position, the No. 1 contact finger completing the stick circuit for holding up the contact fingers. Energy from B-32 will then flow through No. 2 contact finger, wire H1 to bottom contact of acknowledging switch, wire H to magnet valve, wire NH to No. 3 contact finger of RP acknowledging stick relay to wire C.

When the 80 code is in effect, it will be repeated by the master relay and the “L” decoding relay will be energized and the “R” and “A” decoding relays will be de-energized and their contact fingers will assume the down position. Energy is then fed from B-32, No. 1 contact finger of “A” decoding relay, wire A1 to No. 1 contact finger of “R” decoding relay, wire R1 to No. 1 contact finger of “L” decoding relay, wire L lighting the approach cab signal, returning over wire NL to No. 2 contact finger of “L” decoding relay, wire NRI to No. 2 contact finger of “R” decoding relay, wire NA1 to No. 2 contact finger “A” decoding relay and back to wire C. Acknowledgment having been made, acknowledging stick relay RP and LP will become energized and their contact fingers will assume the up position, the No. 2 contact finger of LP acknowledging stick relay furnishing energy to acknowledging stick relay RP which holds its contact fingers in the up position, and the No. 2 contact finger of relay LP completes the stick circuit for holding its contacts in the up position. Under this arrangement, the magnet valve will be energized over the same circuit as previously described.

When there is no code in effect, the master relay will be at rest with the result that the three decoding relays will be de-energized and their contact fingers will assume the down position. Energy is then fed from B-32, No. 1 contact finger of “A” decoding relay, wire A1 to “R” decoding relay, to No. 1 contact finger, wire R1 to No. 1 contact finger of “L” decoding relay, wire S lighting the restricting cab signal returning via wire NS to No. 2 contact finger of “L” decoding relay, wire NRI to No. 2 contact finger of “R” decoding relay, wire NA1 to No. 2 contact finger of “A” decoding relay and returning to wire C.

Acknowledgment having been made, acknowledging stick relay SP is energized and the contact fingers assume the up position, the No. 1 contact finger furnishing the stick circuit and the No. 2 contact finger energizing relay LP and holding its contact fingers in the up position, which in turn holds relay RP contact fingers in the up position and the magnet valve will be energized over the same circuit as previously described.

SUPPRESSING THE SOUNDING OF WARNING WHISTLE

The function of the system to automatically initiate the sounding of the warning whistle may be suppressed by operating the acknowledging switch. When this switch is operated, current flows from wire A1 to wire SP and energizes one or more of the acknowledging stick relays, depending upon the cab signal displayed, which, in turn, will re-energize the magnet valve and stop flow of air to whistle.

SHOP AND ENGINEHOUSE TESTING CIRCUITS

The necessary shop and enginehouse testing circuits shall be installed in accordance with standard tracing.

MAINTENANCE

Inspection and Tests subsequent to arrival at terminal and prior to another dispatchment:

1. Inspect and test the cab signal apparatus and record all defects on form M. P. 62.
2. Note and record whether or not the pneumatic feature of the magnet valve is cut in.
3. Test headlight generator voltage at the generator terminals. Boiler pressure must be within forty pounds of the rated working pressure. Voltage is to be taken for two load conditions:
   (a) Daylight load: cab signal equipment and those lights which cannot be turned off.
   (b) Headlight load (250 watts) added to load (a). Both voltages should be within the limits of 30.5 and 33.5 volts for B-32 and within the limits 340 and 380 for B-300.

4. Examine all apparatus for loose or damaged parts, including receiver, conduit, conduit fittings, piping and pipe clamps.

5. With automatic cab signal equipment in service, place locomotive on test track section, having rail current adjusted as prescribed in L-44 Sup. No. 4.
   (a) Operate indication switch on testing apparatus, to give a clear cab signal. After this signal has been held for a few seconds, change indication switch to give approach-medium cab signal and after warning whistle starts blowing move acknowledging switch to acknowledging position. Warning whistle should sound until acknowledgment has been made. Operate indication switch to give an approach cab signal; warning whistle should sound until acknowledgment has been made; move indication switch to restricting cab signal; warning whistle should sound until acknowledgment has been made.

6. When checking cab indications, check signals, both sides of cab.
   (a) Turbo-generator shall not be operated unnecessarily after inbound inspection, or maintenance work, is completed.

**Monthly Inspection and Tests:**

In addition to inspection and tests required above, the following shall be done:

7. Examine entire automatic cab signal apparatus for general conditions, such as conduit, junction boxes, receiver coils. See that all drain holes in junction and switch boxes are open.

8. All terminals shall be examined, to see that, all wires have tags and eyelets, and that they are secured with double nuts; replace any missing eyelets or tags. Examine all wires at terminals for abrasion of insulation and loose strands of wire which might cause a short circuit or ground. All tags must be of insulating type.

9. Inspect tube sockets for loose or defective contacts.
   (a) Inspect pilotron vacuum tubes for mechanical defects and tube emission as prescribed in L-44, Sup. 6 (See Fig. 5).
   (b) Record on form M. P. 362 emission for each tube, by tube number and location.
   (c) When a tube is applied, the information called for on Tube Label, tracing F-407199, Fig. 6, under column "applied", shall be inserted.
   (d) Tubes which show an emission of less than 13 milliamperes shall be removed from service.
   (e) When a tube is removed, the information called for under column "removed", of Tube Label, shall be inserted.

10. Inspect contacts of all relays (from outside glass cover) for burning or other defects.
    With B-32 at 32 volts, and with coded rail current set at normally 2.0 amperes (maximum 2.25 amps., minimum 1.75 amps.) check the “A”, “R” and “L” decoding relay currents at their respective normal codes (180, 120 and 80). The “A”, “R” and “L” decoding relay current should be adjusted between the limits of 60 and 70 milliamperes. Check the “valley current” in the “A” relay on 120 and 80 code, and in the “R” relay on 80 code. These values must not exceed 11 milliamperes.
    Check the delay time from the change of code current in the track to the blast of the warning whistle. This delay time should be within the limits of 2 to 4 seconds, and may be “counted” in accordance with the method followed in certain air brake practice.
    Check pickup of master relay, as described in Par. 20.
    Record values as found and left on form MP—362 and file with MP—62 report.

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11. Examine generator and dynamotor brushes for tension, contact and wear. See that brush holder leads are free from interference with armature. Rotate armature by hand, noting that rotation is free from grinding. If grinding is observed, renew or clean bearings as necessary.

Wipe off commutators with clean cloth, free from lint. If a high polish has been obtained, no further attention need be given the commutator. If the commutators are rough clean with No. 0000 sandpaper and polish with crocus cloth. Do not use emery cloth.

12. Clean cab signal roundels. Replace any broken or missing glass. See that lamps are screwed in tight, and that shields are not bent and are in their proper position.

13. Megger insulation resistance, between terminals and ground, which must be not less than one megohm:
   (a) Terminals to be meggered.
       C to ground (C on terminal board in end of equipment box).
       A to ground (A on terminal board in end of equipment box).
       R to ground (R on terminal board in end of equipment box).
       L to ground (L on terminal board in end of equipment box).
       1S to ground (On top of master relay).
       Engine lighting circuits to ground.
       B-300 (On terminal board in ends of equipment box).
       FT (On terminal board in ends of equipment box).
       AY (On the "A" relay group).
   (b) Lighting circuits to be meggered thus: with generator running see that all lamps are lighted and main switch open. Close steam valve to generator and when armature becomes stationary, megger +32 to ground.
   (c) Cab signal circuits to be meggered: with all equipment in place including cab indicator lamps, and amplifying tubes and main switch open.

14. Examine and tighten all pipe connections.

Three Year Inspection and Tests:

15. See L-44, Sup. 7, requiring the various units to be removed from service, repaired, inspected and calibrated at relay shops in accordance with the L-51 series of instructions.

Class Repairs:

16. In addition to inspection and tests required under monthly inspection and tests, all cab signal equipment and wiring shall be removed and put in first class condition, and all electrical equipment, including relays, etc., shall be repaired, tested and calibrated in accordance with L-51 series of instructions before being returned to service.

Equipment box shall be cleaned, repaired and painted. Wiring shall be inspected and renewed if necessary.

Renew cab indicator lamps. The removed lamps may be used in locomotive service other than automatic cab signal.

General Warning:

17. Do not remove amplifying tubes from their sockets while lighted. Open the main switch.

The main switch should be opened before changing interstage transformer tap.

Do not permit heating appliances to be used near conduits or hand rail carrying wires, unless full protection is provided. Sheet asbestos may be used. High temperature will also destroy the gaskets of the whistle magnet valve.

Do not attempt to megger any of the circuits while they are energized. The generator must be shut down.

When meggering all circuits, it is imperative that lamps and amplifying tubes are in the sockets and filaments intact.

Voltage Readings:

18. For adjustment of the automatic cab signal apparatus, voltage readings are to be taken at the terminal of generator circuits located in the equipment box. Daily generator voltage readings are to be taken at the generator terminals.

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When adjusting relay pickup, checking tuning, measuring relay currents, etc., voltage should be within the following limits:

- B-32 to C—31.5 volts to 32.5 volts.
- B-300 to C—340 volts to 380 volts.

Receiver Tuning:

Whenever a new receiver bar or amplifier is applied, check tuning by the following method:

1. Connect direct current milliammeter in second stage piotron plate circuit (left-hand jack facing amplifier) and note that reading is substantially zero milliamperes with no current in rail circuit, Fig. 4.
2. Adjust rail circuit for 2.0 amperes non-coded current.
3. Tune receiver by adjusting tuning condenser taps for maximum reading on milliammeter.
4. On amplifiers modified for 91.6-100 cycle service, set tuning condenser at 0.1200 mfd., and omit tuning procedure.

To Adjust Master Relay Pickup:

1. Move switch on test set to the clear or 180 code position and adjust rheostat to increase rail current until master relay begins to operate uniformly.
2. Move switch on test set to non-code position and read rail current. This value of current should be not less than 1.3 amperes and not more than 1.6 amperes. If adjustment is necessary, the taps on the interstage transformer should be used. The pickup current will be at a minimum when bottom tap is used and at a maximum when the top tap is used. Fig. 4.
3. Note that relay operates on other codes with 1.6 amperes in the rail circuit.

INSTRUCTIONS FOR ENGINEMEN

Departure Test:

When taking charge of cab signal equipped locomotive, enginemen shall proceed as follows:

1. Note that cutout cock in magnet valve air supply line is cut in. Start air pumps and generator. See that handle of main switch is in the “on” position. Operate acknowledging switch which energizes magnet valve.
2. Generator must be kept running continuously when automatic cab signal is cut in. Make certain that the generator turbine throttle valve is wide open.
3. Make a departure test after locomotive has been placed on test track, following the procedure outlined in paragraphs 5 and 6 under Inspection and Tests.

General Information for Enginemen:

1. Warning whistle will sound after receiving a more restrictive cab indication until the acknowledging switch is operated. To operate acknowledging switch, hold handle in acknowledging position for about one second, and permit handle to return.
2. All improper operations must be reported on form M. P. 62.

ELECTRO-PNEUMATIC PORTION OF CAB SIGNAL SYSTEM.

Magnet Valve:

1. The magnet valve, figures 2 and 2A, is the means through which the sounding of a warning whistle is brought about. It consists of a magnet and valve bolted on a bracket. All pipe connections are made to the bracket, thus making all parts easily removed for cleaning and repairing, without disconnecting pipes. The supply pressure for the magnet valve is obtained from the signal system, or the independent brake valve supply, at a nominal pressure of 45 pounds. A warning whistle is incorporated in the exhaust port of the magnet valve bracket as a warning to engineer that a more restrictive indication is shown. The whistle will sound continuously until proper acknowledgment has been made.
2. This magnet valve may be used interchangeably with the type specified for “Plug and Cable” type equipment, but must not be used interchangeably with the type specified for “Combined A-R Relay” equipment (L-44, Sup. 1, 2, 3).

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The type used with the “Combined A-R Relay” equipment requires approximately 1/2 second time delay on release to compensate for lack of delay time in the acknowledging relays and to prevent a short blast of the warning whistle with an upward change of cab signal indication.

Strainer:
3. A strainer, tracing F-410874, is connected in the supply line, threaded directly into the magnet bracket.

Cut-Out Cock:
4. A cut-out cock, tracing E-406424, style No. 1, is threaded directly into the strainer. The cut-out cock on all equipments must be installed so that it is closed with handle in horizontal position, and opened by moving handle downward to a vertical position, to guard against accidental closing by vibration.

CLEANING AND INSPECTION
5. At periods not exceeding three months (each third monthly inspection) the magnet valve shall be removed from the locomotive, taken to a clean work bench, dismantled and cleaned by competent men. Do not dismantle or assemble the magnet valve on the locomotive (other than to remove or replace it on its bracket) or other place where dirt, grease or cinders, etc., are liable to enter its mechanism.

Clean the valve parts in turpentine substitute or other approved fluids used in similar air brake work. If valve faces are scored or worn, renew or grind in carefully, and after grinding, thoroughly wash out abrasive.

Test valve for leaks, and see that there is no tendency to stick, particularly in the closed position.

Never place the magnet coil in any cleaning fluid.
Do not lubricate any portion of the magnet valve.
Cleaning date shall be shown on MP-278.

6. At the same period specified above, (Par. 5), remove the cartridge from the strainer, and wash dirt and other foreign matter therefrom, in turpentine substitute or other approved fluids used in similar air brake work. Do not use oil.

7. At the same inspection period specified above (Par. 5), copper pipe between the feed valve and magnet valve shall be removed from the locomotive and annealed.

8. At all inspection periods, inspect piping for fractures, deformation or strains which may cause fractures, etc., and place in first class condition. Inspect cut-out cock and see that it is in proper operating condition.

IMPORTANT
1. Adjustments and replacements of the following units may be made only at relay shops having standard equipment specified therefor, and shall not be made or attempted at enginehouses or other shops:
   (a) Filter units and their assembly, especially filter condenser taps.
   (b) Interstage, master and decoding transformers, (except for adjustment of interstage and decoding transformer taps at their terminal boards).
   (c) Master relays.
   (d) Filament resistors.
   (e) Decoding reactors, condensers and rectifiers.
   (f) Track receiver coils and coil cases.

2. Seals shall not be broken on any unit, and no relay shall be dismantled in any way (except in relay shops).

REMARKS
Decoder is shown in Figure 7; relay group in Figure 8.

H. W. JONES,
Chief of Motive Power.

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FIG. 2

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FIG. 4

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THE PENNSYLVANIA RAILROAD
LOCOMOTIVES & PASSENGER ROLLS
CODE SYSTEM
FOUR INDICATION CAB SIGNAL
WITH WHISTLE & ACKNOWLEDGER
TUBE LABEL

ISSUED: 12-10-1935
ALTOONA: 10-29-35

RE-ISSUED
ALSO FOR L.I.R.R. THREE
INDICATION CAB SIGNAL
WITH WHISTLE & ACKNOWLEDGER

THIS TRACING SUPERSEDES
TRACING F-85161 WHICH
HAS BEEN MADE OBSOLETE
ON ACCOUNT OF Issuing
NEW INSTRUCTIONS,
10-29-35.

AFTER WETTING READY
GUMMED LABEL PLACE
SAME ON TUBE AS FOLLOWS:
LABEL A SHOULD BE APPLIED
WHEN TUBE IS NEW, AND
LABEL B SHOULD BE
APPLIED WHEN TUBE IS
REMOVED FROM SERVICE.
AFTER INSERTING DATA
ON TUBE LABEL LACQUER
OVER LABEL WITH ZAPON
LACQUER REF. 30-2231
AS MANUFACTURED BY P.R.R.
MANUFACTURING LABORATORY
ALTOONA, PA. OR ITS
EQUIVALENT.

S.H. APPLIED

MR. TUBES A.C.E.M. DATE

ENG. NO. RMRS. A.C.E.M. DATE

3"

ONE THUS READY GUMMED LABEL
PER TUBE APPLIED AS SHOWN.
M.P. 366-A

REMOVED

ENG. NO. CAUSE A.C.E.M. DATE

2"

ONE THUS READY GUMMED LABEL
PER TUBE APPLIED AS SHOWN.
M.P. 366-B

FIG. 6

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