The purpose of this instruction is to establish uniform procedures in the adjustment of steady energy DC track circuits employing standard track relays fed from one cell of storage battery, and to obtain maximum practical shunting sensitivity consistent with apparatus employed and variations in ballast resistance.

BATTERY END

The adjustments covered by this instruction are based on a total resistance of 0.1 ohm in the battery leads to rail, and an inserted resistance of 1.0 ohm with a lead cell, and 0.65 ohm with a nickel-iron cell, a nickel-cadmium cell, or primary cells. Primary cells must be connected in series, parallel, or series-parallel, to provide a shunt current of 1.6 amperes at a nominal 1.2 volts. It is recommended that a minimum of 2000 ampere-hours capacity be installed for each primary cell powered track circuit.

Normally, a 1.0 ohm fixed resistor can be used with a lead cell. A Safetran type 029602-3X 1.0 ohm adjustable resistor set at 0.65 ohm can be used with a nickel-iron cell, a nickel-cadmium cell, or with primary cells; however, it is recommended that an adjustable resistor be used for all circuits.

If the leads between the battery and the rails are longer than normal, the additional resistance introduced by the added length must be taken into account when making adjustments. To adjust the total limiting resistance (leads plus inserted resistance), connect a low resistance shunt (#6 AWG copper or larger) across the rails by means of clamps at the battery end of the track circuit and, with the charger off, set the adjustable resistor to allow approximately 2 amperes to flow. With primary cells, connect a voltmeter across the battery terminals and adjust the total resistance to .75 ohms by calculation using E/I.

When making adjustments, a low resistance ammeter with leads as short as practicable should be used and the current should be read on the 15 ampere scale of the meter.

RELAY END

To facilitate adjustment, the amount of series resistance which may be inserted in the relay leads has been calculated for various minimum ballast settings and the results plotted as curves which form a part of this instruction. The calculations are based upon a bonded track resistance of 0.025 ohms per thousand feet which is the equivalent of 127# rail with rail-head bonds, or upon welded rail track resistance of 0.008 ohms per thousand feet.

Three minimum ballast settings are plotted for each type of relay on storage battery circuits. In addition, a one ohm ballast curve is given for primary battery circuits. The four ohm ballast setting may be used where ballast and ties are in excellent condition, the three ohm setting may be used generally under average ballast and tie conditions, while the two ohm, or one ohm setting should be used only where ballast and ties are poor.

USE OF ADJUSTMENT CURVES

After determining that proper limiting resistance has been inserted in the battery leads, select the Figure which covers the type of relay and cell to be used. From the minimum ballast curve (2, 3, or 4 ohms) read the series resistance to be inserted in the relay leads for the length of circuit under adjustment.

For example, using plan CS-9005, sheet 2 which covers a PN-150B relay Dwg N322501 and a nickel-cadmium storage cell, the amount of resistance to be inserted to adjust a 3,000 foot circuit to 4 ohm ballast resistance per thousand feet is found to be 2.25 ohms.

In some cases within interlocking limits, an additional relay is installed in a turnout along with the regular relay on the main track. This calls for adjusting a circuit with two relays fed from the same cell. To make this adjustment, the total length of track circuit is taken as the distance from the battery end to the relay end of the circuit on the main track plus the length of the turnout. Using this total circuit length, the amount of series resistance to be added is read from the curve and 85% of the value indicated inserted in each relay.

MEASURING BALLAST AND RAIL RESISTANCE

It is unnecessary to measure ballast and rail resistance in order to use the adjustment curves, however, when a circuit does not operate properly with normal adjustment or where it is suspected that some abnormal condition obtains within the circuit, it may be necessary to measure its characteristics.

To measure ballast and rail resistance, disconnect the track relay and place a low resistance shunt attached to the rail with clamps, across the track at the relay end of the circuit. Measure the voltage (E) across the rails and the current (I) to track at the feed end with the circuit so shunted. The approximate rail resistance R_m is then determined by E/I. Remove the shunt and again read the voltage across the rails and the current to track at the feed end. The approximate ballast resistance B_m is then determined by E/I.

For all practical purposes these values for rail and ballast resistance may be assumed to be correct, however, on long circuits having very low ballast and high rail resistance, an appreciable error may exist. The degree of error can be readily determined by dividing R_m by B_m to arrive at a ratio. In Figure A, the ratios R_m / B_m are plotted as abscissae enabling a correction factor to be read from the curve. Multiplying R_m by the correction factor and dividing B_m by the correction factor will give true values for rail and ballast resistance. It will be noted from Figure A that ratios less than .15 result in errors of less than 5.5% which may be neglected.

Dividing the measured rail resistance for the circuit by the length of the circuit in thousands of feet will give the rail resistance per thousand feet of track, which value should not exceed .025 ohm.

Multiplying the measured ballast resistance for the circuit by the length of the circuit in thousands of feet will give the ballast resistance per thousand feet of track.

To determine minimum ballast resistance for a particular circuit, readings should be taken during, or shortly after a rain. The lowest ballast resistance for any circuit usually occurs at the start of a rain storm after a long dry spell, however, readings taken on wet track should be sufficiently accurate as the adjustment curves are based upon maximum rail resistance, minimum ballast resistance, maximum relay working current, and a minimum battery voltage all occurring at the same time.

SHEET 1
CONT'D ON SHT 2

CONRAIL

CS-9004

STANDARD

TRACK CIRCUIT ADJUSTMENT AND MEASUREMENT OF BALLAST AND RAIL RESISTANCE-INSTRUCTION

DEC. 4, 1978

Approved [illegible]
Chief Engineer C&S