

PROTECTIVE GROUNDING SYSTEMS
EQUIPMENT GROUND SYSTEM, CENTRAL OFFICES
GENERAL INTERFACE REQUIREMENTS FOR
MANUAL TOLL RELAY RACK GROUND SYSTEM
POWER SYSTEMS

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1. SCOPE

1.01 This section covers equipment requirements and engineering information for the design of a combined discharge-framework ground system to serve Manual Toll relay rack mounted equipment installations. It also covers interface requirements between that ground system and the CO GRD system.

1.02 This section is supplementary to Section 802-001-192, Equipment Ground Systems, Central Offices. Other Protective Grounding Systems sections pertaining to equipment grounding in Central Offices are listed in 802-001-192, SCOPE.

2. GENERAL

2.01 The standard battery distribution system per SD-81142-01 is normally used to distribute DC power to components of the Manual Toll System. The Manual Toll equipment complex primarily consists of one or more lines of manual switchboard positions and service desks in an operating room, and one or more lines of relay rack (RR) bays located in an equipment area outside the operating room. The standard DC battery distribution system supplies 24-volt and 48-volt power directly from the power plant battery control boards to:

(a) The cable turning section (CTS) of each switchboard line, extended therefrom to fuse panels in individual positions thereof, where individual conductors are branched to serve load circuits in the switchboard line.

(b) Fuse boards in the equipment area, where individual conductors are branched to serve load units mounted on relay rack bays.

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2.02 A description of the characteristics of the ground portion of DC distribution system of the Manual Toll System equipment follows. References (C), (F), (G), (H), (J) refer to ground distribution conductors similarly identified on SD-81142-01.

A. Operating Room

2.03 Switchboard positions are equipped with fuse panel ground buses joined together to form a continuous ground bus throughout the line, insulated from contact with the switchboard frame. A stile strip ground bus, similarly joined but having contact with position frame metal, is also provided. Both ground buses are connected to the BCB ground bus (F, G) to provide a calculated DC resistance path for ground current return to the battery. Additionally, the stile strip ground bus is connected to the ground bus of an RR bay mounting the transformer that supplies low voltage AC to idle indicating and busy lamps in the switchboard (H). This calculated conductor serves as a neutral conductor for AC current between the transformer and the stile strip bus. It also serves as an equipment ground for the switchboard frames.

2.04 Toll operating room desks are equipment grounded through individual ground conductors routed to RR ground buses (SD-81142-01, Fig. 11).

2.05 When a CO GRD system is incorporated into a Manual Toll system installation and the ground conductors described above are installed as part of the DC distribution system, extension of additional ground conductors into the operating room for equipment grounding purpose is not required.

B. Equipment Area

2.06 The Relay Rack (RR) Ground System application described herein is confined to installations of relay rack mounted equipment provided to function in conjunction with a manual switchboard serving as a Manual Toll switching system. The grounding system is considered obsolete and is no longer standard for any application other than this one. It may be encountered in installations of other manual systems relay racks and the engineering requirements expressed herein may be applied to those installations if inadequate grounding is detected.

2.07 Principal characteristics of the Manual Toll RR ground system are:

(a) Relay rack frames are arranged in frame lines and equipped with frame ground bus bars bonded with junction plates to form a continuous run along the frame line.

(b) Relay rack mounted equipment circuits utilize the frame ground bus bar run as a DC current return path to the battery.

(c) The frame ground bus bars are connected at the head of the line to a Main Aisle Ground Equalizer conductor (multiple frame lines) or to a point on a major discharge ground conductor (one or two frame lines).

(d) The Main Aisle Ground Equalizer forms a common path for ground current from every frame line ground bus run. Fuse board frame ground bus bars are joined to RR ground buses and to ground buses of fuse panels mounted on fuse boards. Ground current is thereby afforded a path to battery via the ground conductors extended from the power plant battery control board (BCB) to fuse panel ground buses (C). An additional ground conductor (J) is extended directly from the Equalizer to the BCB ground bus, which acts, in parallel with conductors (C), as a ground current return path.

2.08 This method of providing a return path for DC power ground current to battery has been found to be deficient in some Manual Toll system installations. The ground bus bars provided on some relay rack bays are not large enough to carry the cumulative circuit ground current collected along the frame line to the Main Aisle Equalizer without imposing a voltage drop in excess of that allowed by the power distribution circuit voltage drop requirements.

2.09 Part 3 of this section provides detailed instructions on methods to be employed to reinforce the ground system to ensure an adequate ground path. Methods include replacement of RR ground buses and supplementary bonding with cable conductors. Prior to the issuance of this section, engineering instructions covering actions to be taken to relieve the deficiency were covered in various memoranda. This section incorporates those instructions and supersedes the memoranda.

C. Applications

2.10 New frame lines of Manual Toll relay rack bays shall be equipped with a ground system as described herein. When an addition of relay rack bays is made to an existing frame line that has not been installed or modified to conform with requirements outlined herein, it is recommended that a thorough study be made of battery ground current return paths throughout the system. Where a conductor deficiency is suspected, that portion of the ground system should be reinforced in the most practical manner. A judicious use of 350,000 CM ground bonds along frame line ground bar runs and between such runs and fuse board or BDFB ground bus bars that reinforces deficient ground current paths will generally prove to be more economical than an attempt to modify the entire installation to agree with physical configurations described hereunder. Ordinarily, removal of any conductor that serves as a ground current conductor is not warranted, except where it might physically interfere with the addition of a conductor of greater capacity.

2.11 For reason of economy, it is recommended that retrofitting of existing frame lines be made only if there is reason to believe that a noise or other operational problem exists because of resistance ground paths. When such problems exist, the addition of a CO GRD system (Section 802-001-193) solely to serve this system may not be effective or economically justified. Connection via a CO GRD path to the earth electrode will generally contribute little to reduction or equalization of transient voltage differentials impressed on frame line ground bus bars by current flow through points of excessive resistance. The CO GRD system, which parallels the discharge ground path between the power plant and the Main Aisle Equalizer, is, in effect, in series with frame line ground bus bars and will have no effect on voltage differential between points on the ground bus bar runs.

2.12 To eliminate noise problems, it is recommended that a study of ground paths through frame line bus bar runs, between different frame lines, from frame lines to fuse boards and BDFBs, and to power plants be made. Suspected paths of excessive resistance should be reinforced by means of 350,000 CM bonds, replacement of inadequate ground bus bars and/or reinforcement of power distribution conductors. Addition of a CO GRD system should be considered only after exhausting

other methods. If a CO GRD system exists to serve other communication equipment on the floor, it shall be extended to the Main Aisle Equalizer, to take advantage of the improved ground plane equalization and equipment grounding provided by that system.

D. Power Supply From a BDFB

2.13 Often, one or more BDFBs are installed in the vicinity of the Manual Toll RR installation. Frequently, Carrier, Repeater or other types of equipment frames that provide a service associated with the Toll System are interspersed in the RR frame lines or are installed in frame lines adjacent to the RR lines. These equipment frames generally receive power over paired battery and ground conductors from a BDFB rather than from the Manual Toll fuse boards. Additionally, certain equipment units mounted on Manual Toll relay racks may be fed by paired leads from a BDFB. When a frame containing equipment fed by paired leads is equipped with a ground bus that forms a portion of a frame line ground bus run, a bond between the point of termination of the ground lead on the equipment unit and the frame ground bus is required.

2.14 In certain installations, a BDFB may be used as the originating point for power feeders serving fuse boards of the Manual Toll system, instead of the power plant battery control board.

2.15 When a BDFB distributes all or any portion of the DC power to Manual Toll fuse boards or to equipment mounted on frames in RR frame lines having a frame line ground bus that connects to a Main Aisle Ground Equalizer, a direct 750,000 CM bond must be provided from the Equalizer to the BDFB ground bus.

2.16 The addition of bonds as described above is intended to provide a ground current return path through the RR Ground System for DC current distributed from BDFBs to equipment in the RR area. The bond path is in parallel to the ground conductor of the paired conductors extended from the BDFB. The principal effect is to integrate the BDFB and RR ground systems so as to ensure maximum equalization of voltage between the two ground systems. Ground conductor (J) of the Manual Toll distribution system shall be provided from the power plant to the Main Aisle Ground equalizer as specified in SD-81142-01 when power

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is distributed to switchboards and/or fuse boards directly from the power plant battery control board. When all DC power is distributed from a BDFB, and the BDFB ground bar is bonded to the Main Aisle Ground Equalizer and either the BDFB ground bus or the Equalizer is connected to a CO GRD horizontal equalizer, ground conductor (J) may be omitted.

E. Equipment Grounding

2.17 Prior to the introduction of the CO GRD system (Section 802-001-192) in central offices, Manual Toll system frames were assumed to be adequately grounded through the ground path afforded by conductors of battery distributing circuit SD-81142-01 plus incidental ground paths that occurred through frame metal, cable racks, steel superstructure, etc. The CO GRD system supplements these paths to provide a known low impedance path to ground that integrates the Manual Toll system ground plane with that of other communication systems, building steel and other metallic objects to form a common low impedance ground plane.

2.18 The CO GRD system is extended to the Manual Toll system ground plane by means of a 750,000 CM horizontal equalizer that is connected to the Main Aisle Equalizer. The Main Aisle Ground Equalizer is bonded to ground bus runs in each frame line. Ground buses are mounted directly on frame metal, thereby completing a ground path from each frame to the CO GRD system. The CO GRD horizontal equalizer is also connected to BDFB ground buses and crossbar type equalizing center Main Aisle Ground Equalizers that may be located in the same quadrant of the floor, and to other similar ground points in other quadrants via other horizontal equalizers extended from the floor CO GRD bus bar. By this means, all frames on a floor, and other metallic objects, are bonded into a common low impedance ground plane. Additionally, the horizontal equalizers of the CO GRD system bond together all of the ground conductors that serve major power distributing centers (BDFBs and equalizing centers) on a floor. This bonding arrangement, in effect, combines the various ground current return paths into one common path from the floor to the power plant.

F. Ground System Material

2.19 Terminal connectors, wire, and other material used in the fabrication of the ground system

shall conform with requirements expressed in Section 802-001-190.

3. RELAY RACK GROUND REQUIREMENTS

3.01 Frames utilized to mount equipment units in the equipment area of a Manual Toll switching installation are generally referred to as Relay Rack (RR) bays. Primarily, the term refers to a framework utilized to mount miscellaneous equipment units. When a bay is totally dedicated to mount equipment of a single type or to perform a single function associated with a communication system, it is usually identified by a distinctive name derived from the function. These dedicated bays are not normally referred to as Relay Rack bays, nor do they necessarily have the same characteristics as the Relay Rack bays used in Manual Toll Relay Rack installations; 11-foot, 6-inch high bulb angle framework; ground bus bars mounted at top front, arranged for connection to ground bus bars of adjacent bays. Dedicated bays may be assembled on angle, duct or other type frames and equipped with incompatible ground bus bars, or with no ground bus bars.

3.02 Dedicated bays may be installed in lines with standard Manual Toll Relay Rack bays. If not equipped with ground bus bars, or with ground bars of inadequate capacity, or with bars that cannot be interjunctioned to form a continuous frame line ground bus run, a modification is necessary, as described hereunder.

3.03 In the following descriptions, ground bus bars utilized to form a continuous ground path in a frame line are referred to as Relay Rack (RR) ground bus bars, whether mounted on an RR bay or a dedicated bay. Individual frames are referred to as RR bays. Frame lines are referred to as RR lines. The variety of dedicated bays that may be installed in RR lines are too great to allow individual identification; therefore, they too are referred to as RR bays.

Relay Rack Ground, Manual Toll Systems

3.04 Relay rack lines utilize a combination discharge-framework ground system. Ground bus bars, mounted directly on framework steel, are located at the top of the bays. The bays are normally placed in frame lines and ground bus bars are joined together with junction plates to form a continuous battery return conductor. The

bus bar run functions as a collector of DC ground current from the load units mounted on the relay racks and, through access to CO GRD, as framework ground. Typical relay rack ground applications are illustrated in Fig. 1. General requirements for design of an effective ground system for a toll relay rack installation are specified hereunder.

Testboard Ground, Manual Toll Systems

3.05 Testboards associated with manual toll systems are mounted on framework compatible with that used for relay rack (RR) bays. These frames are equipped with ground bars junctioned to form a continuous ground conductor. Lines of testboards are generally located adjacently to the RR bay lines. Connection of the testboard line ground bars shall be made to the main aisle ground equalizer serving the RR lines, identical to that described for relay rack ground bus bars.

A. Relay Rack (RR) Ground Bus Bars

3.06 RR bays are equipped in the shop with any of a variety of ground bus bars. Various frames may be equipped with one of the following arrangements, adequate for ground current requirements for the bay, but not necessarily adequate for current that may be imposed on the bar when it functions as a conductive path for an entire frame line. RR bays may be:

- (a) Shop equipped with 1/4- by 1-inch copper bar
- (b) Shop equipped with 1/8- by 1-inch copper bar
- (c) Shop equipped with bar of other material than copper
- (d) Not equipped with bar.

3.07 Since these bars are junctioned to form a continuous path for battery return current along a frame line and there is no facility available for predetermining their location in a frame line ground path prior to manufacture, the presence of, and location of conditions (a), (b), (c) and (d) above must be ascertained after RR lines are laid out. Provision for replacement of inadequate bars in the field is required. Such replacement shall be in accordance with the following requirements.

3.08 RR line ground bus bar runs are connected to a Main Aisle Ground Equalizer or otherwise connected so as to provide a low impedance path through discharge ground conductors for return of current to batteries. The RR ground bar in the RR bay nearest the main aisle is connected to the Equalizer with a 350,000 CM conductor. This ground bar must carry the total current collected from circuit grounds by the individual bars in the line. It is assumed that a 1/4- by 1-inch copper bar (approximately 318,000 CM) suffices for this purpose. It is also assumed that ground bars other than 1/4- by 1-inch copper will have adequate capacity to serve as a conductor for currents collected in a complete or partial line composed solely of bays that are shop equipped with such bars. Ground bars that do not provide capacity equal to that supplied by 1/4- by 1-inch bars are considered inadequate to serve as a conductor for currents emanating from a bay that is shop equipped with 1/4- by 1-inch bars, however. When such bars of lesser capacity serve as an intermediate junction between 1/4- by 1-inch bars, they must be reinforced or replaced so that a continuous path at least equivalent to 318,000 CM of copper exists to every shop or field furnished 1/4- by 1-inch bar. Reinforcement or replacement may be accomplished by the following means:

- (a) 1/8- by 1-inch copper bars may be replaced by 1/4- by 1-inch bars or reinforced by addition of a second identical 1/8- by 1-inch bar or bridged by a 350,000 CM bond between 1/4- by 1-inch bars on either side.
- (b) Bars of material other than copper may be replaced with 1/4- by 1-inch copper bars or may be bridged with a 350,000 CM bond between 1/4- by 1-inch bars on either side.

3.09 RR bays that are not shop equipped with RR ground bars need not be equipped if they are installed in a complete line of unequipped RR bays (Fig. 1D, RR116) or appear at the end of a line of bus bar equipped RR bays (Fig. 1D, RR111.4). When so located they require a No. 6 AWG bond from each frame to either a 1/4- by 1-inch bar on a preceding bay or the main aisle ground equalizer, for framework grounding (FRWK GRD) purpose. A FRWK GRD conductor serving an entire frame line shall be No. 2 AWG (preferred) or No. 6 AWG (minimum) with No. 6 AWG bonds to each frame. When located in a frame line so

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that they disrupt continuity of the frame line ground unequipped RR bays may be:

- (a) Equipped with 1/4- by 1-inch copper bars.
- (b) Bridged with a 350,000 CM bond between 1/4- by 1-inch or other bars on either side of the unequipped bay. The RR bay must be framework grounded with No. 6 AWG terminated at 350,000 CM bond or preceding bus bar (Fig. 1D, RR113.2, 3).

3.10 Gaps occurring in an RR line because of reservation of space for a future bay, or bays, or because of interference by a building column or for other reason, that disrupts ground continuity shall be bonded either:

- (a) With a ground bar supported by junction plates extended from ground bars on existing bays, when a single future bay gap or lesser space is bridged (Fig. 1E, RR111.2)
- (b) With a 350,000 CM bond between bars on either side of the gap when (a) is not applicable (Fig. 1D, RR112.2, 3).

3.11 Equipment location on some bays not equipped on a standard basis with ground bars, such as 4W term set bays, may interfere with the addition of a ground bar in the normal front location. It is recommended that a 350,000 CM bond be provided around such bays; however, if desired, the bar may be mounted on the rear of the bay and connected with 350,000 CM bonds to adjacent bay ground bars (Fig. 10, RR103.3).

3.12 A variety of arrangements of ground bars and bonds resulting in a low resistance path for battery return current are illustrated in Fig. 1. Bus bar (A) represents bars furnished by the shop or replacement for bars (B) or (C), or bars added on bays not previously equipped with bars. Bus bar (A) may also represent a lamination of two (B) bus bars. Junction (D) represents any junction that provides adequate capacity. Bus bar (F6) represents an (A) ground bar mounted on the rear of an RR frame.

3.13 Ground bars, junction plates and methods of bonding gaps in ground bar runs, applicable

to Manual Toll system RR installations, are covered on the following drawings:

- (a) T-941276
- (b) ED-90484-72
- (c) ED-91210-51
- (d) ED-92971-70
- (e) ED-3C014-51
- (f) H-242-557
- (g) H-255-027

B. Main Aisle Ground Equalizer

3.14 The Main Aisle Ground Equalizer consists of one (J) or two (J3) 750,000 CM type RHW stranded copper conductors, (shown in Fig. 1D) routed along the main aisle and supported with cable supports from cable rack or superstructure. The entire run should be accessible for addition of taps and for maintenance. When RR lines are located on one side only of a main aisle, a single conductor is required. When RR lines are located on both sides of a main aisle, two conductors are required, run on either side of the main aisle cable rack. A double run must be joined together at each end, either directly or by a short section of 750,000 CM cable tapped between the two runs.

3.15 The maximum length of Equalizer run shall not exceed 50 feet from the point of connection of the equalizer ground conductor (SD-81142-01 lead J) to the furthest point of connection to an RR line ground bus run (F1). When a run exceeds this length, additional equalizer ground conductors (SD-81142-01 lead J) must be provided to satisfy the requirement.

3.16 A Main Aisle Ground Equalizer (J) is not required when an RR installation consists of one or two RR lines and power is distributed through a fuse board in one of the frame lines. The fuse board receives DC power via paired battery and ground conductors from the power plant (SD-81142-01 leads A, B, C). A single RR line (Fig. 1A) shall be grounded as follows:

- (a) SD-81142-01 lead C, which connects the power plant ground bus to the fuse panel

ground bus in the fuse board, shall be calculated to carry current normally carried by leads C and J. (See SD-81142-01, Tables 1 and 3.)

(b) The fuse panel ground bus shall be bonded to the fuse board bay RR ground bus with 350,000 CM conductor or a bus junction of equivalent capacity.

(c) When a CO GRD system exists, the RR line ground bus shall be bonded to the CO GRD system (to a CO GRD bus, CO GRD horizontal equalizer or to a BDFB ground bus) with a 350,000 CM conductor (Fig. 1A, 1B, (F)).

3.17 When the installation consists of two RR lines, grounding requirements are identical to that outlined above, except that in addition a 350,000 CM bond shall be provided between ground bar runs of the two RR lines, connected between the RR ground bus of the fuse board and the RR bay directly opposite [Fig. 1B, (F2) or (F4)].

3.18 Main Aisle Ground Equalizers require connection to other ground system components as follows:

- (a) RR line ground bus bars
- (b) Power plant discharge ground system
- (c) CO GRD system.

Connection to RR Line Ground Bus Bars

3.19 RR line ground bus runs shall each be connected to the Main Aisle Ground Equalizer with a 350,000 CM conductor (F1) extended from the RR ground bus bar (A) of the RR bay nearest the Main Aisle. The conductor shall be terminated on the RR ground bus bar with a two-hole bolted tongue crimp (preferred) or pressure type connector, either directly or by use of a copper detail mounted on the bus bar, utilized to facilitate mounting of the terminal (T-491276 G-6 typical). Connection to the 750,000 CM Main Aisle Ground Equalizer shall be made with KS-5537 parallel cable taps.

Connection to Discharge Ground System

3.20 Lead J, SD-81142-01, provides a current return path to batteries. The conductor size is calculated for an allowable voltage drop. Dependent on length of run and calculated ground current, it

may consist of one or more 750,000 CM or smaller wire(s). The conductor must be extended to each Main Aisle Ground Equalizer conductor, preferably at approximate midpoint on the Equalizer and never more than 50 feet from the furthest point of connection of the Equalizer to RR line ground bus bar runs. Connection to the Equalizer shall be as specified in SD-81142-01, Equipment Notes.

3.21 When a RR installation receives power from a BDFB, as described under Part 2—Power Supply from a BDFB, a 750,000 CM bond shall be provided between the BDFB ground bus and the Main Aisle Ground Equalizer as shown in Fig. 1D (J2). The point of connection shall be as near to the midpoint of the Equalizer run as practicable. The bond provides a path for ground current flow between the discharge ground conductors serving the BDFB and the Equalizer and serves as an extender of the CO GRD system to frames connected thereto.

3.22 When the entire power supply to equipment in an RR installation is distributed through a BDFB bonded to the equalizer, lead J, SD-81142-01, may be omitted.

Connection to CO Ground System

3.23 When a CO GRD system exists, a 750,000 CM horizontal equalizer shall be connected to the Main Aisle Ground Equalizer to provide common ground current path between the RR ground system and other discharge ground conductors that terminate on the floor. The CO GRD equalizer shall be terminated at each 750,000 CM conductor that serves as a Main Aisle Ground Equalizer, at a point as near as practicable to the point of connection of discharge ground lead J per SD-81142-01 (Fig. 1D). Additionally, CO GRD—Main Aisle Ground Equalizer bonding requirements covered in Section 802-001-193, Part 3 C and Fig 2, shall be complied with.

3.24 Normally, every BDFB must have a direct bond between its ground bus and a CO GRD horizontal equalizer. When a BDFB is located in the vicinity of a Main Aisle Ground Equalizer and provides all or part of the power to a Manual Toll RR system, a 750,000 CM bond (J2) must be provided between the BDFB ground bus and the Main Aisle Ground equalizer. When this arrangement exists and the length of the bond is 25 feet or less, the CO GRD horizontal equalizer may terminate

at either the BDFB ground bus or the Main Aisle Ground Equalizer, whichever represents the shortest run to the CO GRD bus, but need not be extended to both. Conductor (J2) is considered to be equivalent to an extension of the CO GRD horizontal conductor.

3.25 In buildings not equipped with a CO GRD system, the CO GRD connection to the Main Aisle Ground Equalizer does not exist. Ground reference in such installations depends on paths to ground through DC power system discharge ground conductors and such incidental ground paths as may exist.

C. Framework Ground Extensions From Main Aisle Ground Equalizer

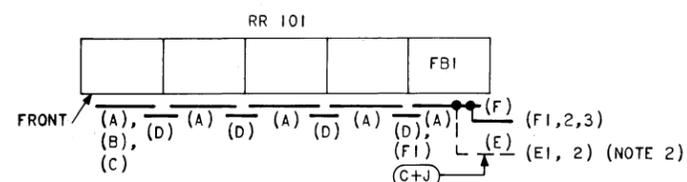
3.26 Frameworks, cabinets, and other equipment units in the vicinity of the main aisle ground equalizer may be equipment grounded therefrom when a CO GRD horizontal equalizer is connected to the equalizer. Typical applications are depicted in Fig. 1D by conductors (L), (M) and (H3). In general, a No. 2 AWG conductor shall be run when multiple lines of frames are to be grounded, with No. 6 AWG bonds therefrom to each framework. In the case of duct type bays that utilize a 1-inch pipe support along the length of the duct bay line, a single No. 6 AWG bond may be extended to

the pipe to effectively ground the line supported by the pipe.

D. Manual Toll Relay Racks Interspersed With Other System Frames

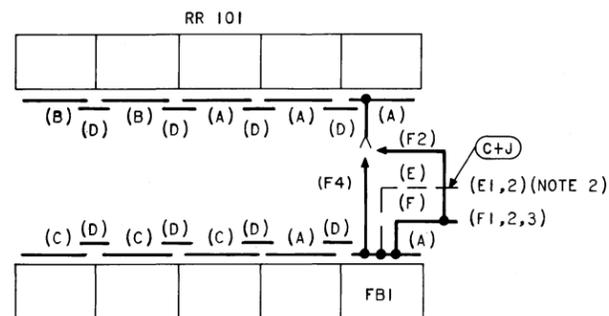
3.27 Small installations of Manual Toll RR such as depicted in Fig. 1A and 1B may be located in frame lines with frames associated with other communication systems. When so located in conjunction with Crossbar type switch frames utilizing equalizing centers, the Main Aisle Ground Equalizer conductor of the equalizing center system may be used as the point of termination for the 350,000 CM RR GRD bond (F), provided that a CO GRD system connects to the Main Aisle Ground Equalizer. If the path of ground conductance to the CO GRD bus is circuitous (ie, forms a loop), the RR GRD bond (F1) may alternately be terminated on a CO GRD horizontal equalizer or a CO GRD bus bar, whichever affords a reasonably direct path to the CO GRD bus bar.

3.28 When such small installations are located with other systems equipment that utilize BDFBs for power distribution, and the BDFB ground bus connects to a CO GRD system, the 350,000 CM bonds may terminate at the BDFB ground bus if that provides a reasonably direct path to the CO GRD bus bar.



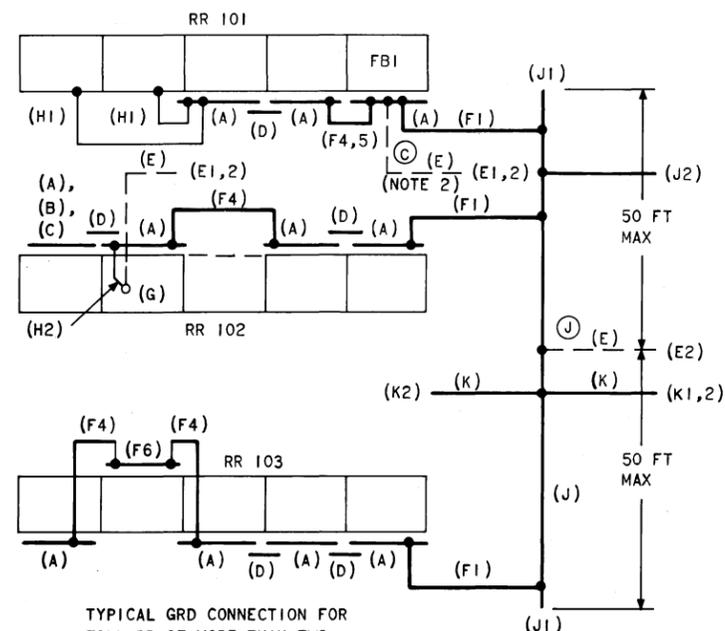
TYPICAL GRD CONNECTIONS FOR A SINGLE LINE OF TOLL RR

FIG. 1A



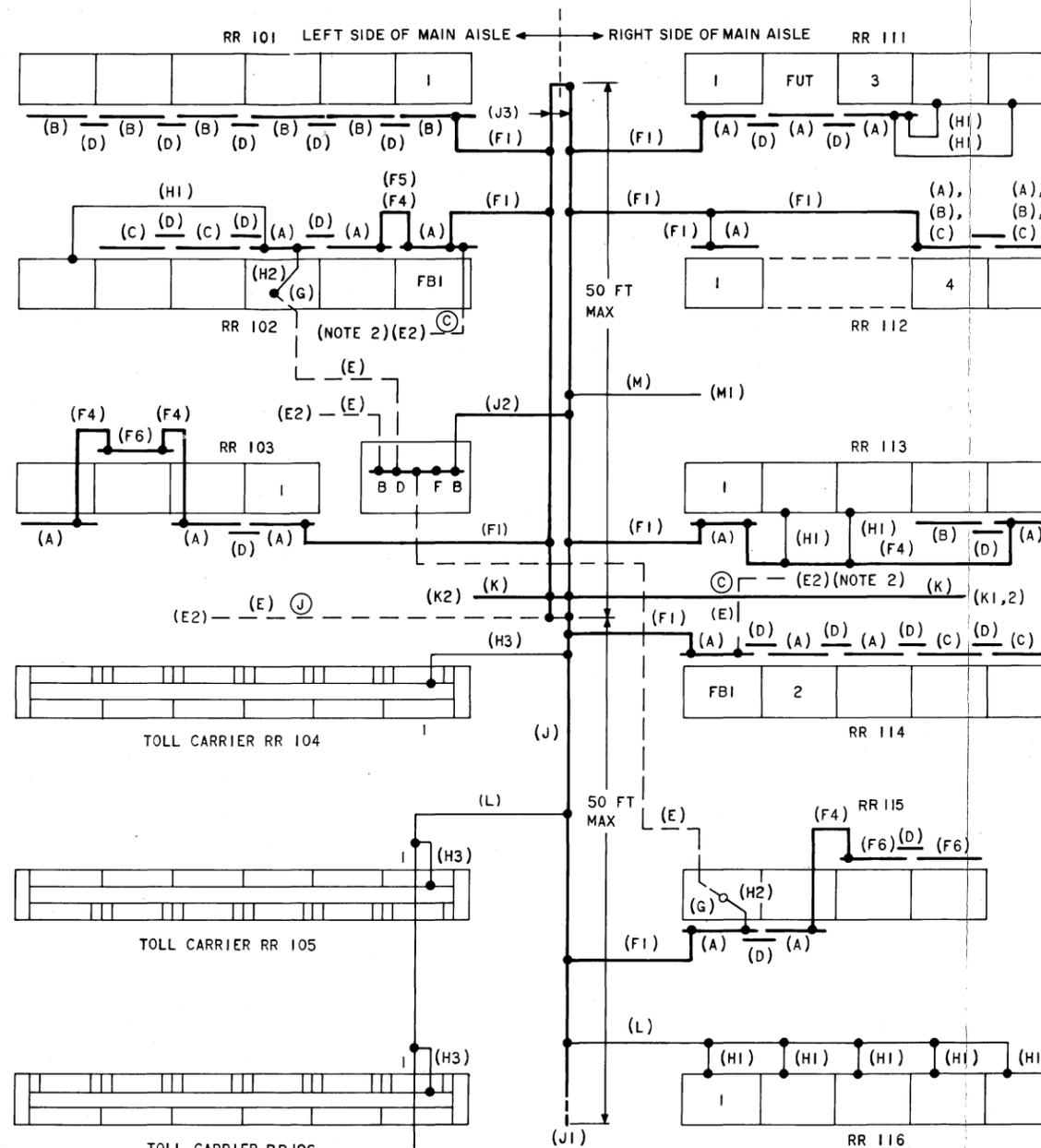
TYPICAL GRD CONNECTION FOR TOLL RR CONSISTING OF TWO LINES ULTIMATELY

FIG. 1B



TYPICAL GRD CONNECTION FOR TOLL RR OF MORE THAN TWO LINES

FIG. 1C



TYPICAL GRD CONNECTION FOR TOLL RR LINES INSTALLED ON TWO SIDES OF A MAIN AISLE, WITH ASSOCIATED BDFB. VARIOUS ACCEPTABLE METHODS OF EXTENDING CONDUCTIVE CAPACITY, EQUAL TO OR EXCEEDING EQUIVALENT TO 300,000 CM COPPER CONDUCTOR TO ALL BAYS E/W 1/4 X 1 COPPER BARS, ARE DEPICTED. ARRANGEMENT SHOWN IS INTENDED AS A GUIDE FOR DESIGN OF GROUND SYSTEM FOR NEW INSTALLATIONS OR MAJOR ADDITION TO EXISTING INSTALLATION. RETROFIT OF EXISTING INSTALLATIONS IS RECOMMENDED ONLY IF NOISE PROBLEMS ARE PROVEN TO BE CAUSED BY INADEQUATE GROUNDING.

FIG. 1D

NOTES:

- REFERENCE DRAWINGS:
 - A. T-941276
 - B. ED-62545-11
 - C. ED-90484-72
 - D. ED-91210-51
 - E. ED-92971-70
 - F. ED-3C014-51
 - G. H-242-557
 - H. H-255-027
 - J. SD-81142-01
- DISCH GRD CONDUCTORS SHALL TERMINATE ON FUSE PANEL GRD BUS IN FUSE BAY, WITH 350 MCM OR EQUIVALENT BUS BOND TO RR GRD BUS.
- DESIGNATIONS (A), ETC., IDENTIFY BUSBARS AND CONDUCTORS THAT FORM THE RR GROUND SYSTEM. WHERE COMMAS SEPARATE DESIGNATION, (IE, (A), (B), (C)) IT INDICATES THAT ANY ONE OF THE CONDITIONS MAY APPLY. MULTIPLE SYMBOLS NOT SEPARATED BY COMMAS INDICATE ALL CONDITIONS APPLY.
- (C) OR (J) (E2) DENOTES GROUND CONDUCTORS C OR J PER BATTERY DISTRIBUTING CKT SD-81142-01.

LEGEND

- (A) 1/4 X 1 COPPER GRD BUS
- (B) 1/8 X 1 COPPER GRD BUS
- (C) GRD BUS OF MATL OTHER THAN COPPER
- (D) GRD JUNCTION BUS
- (E) DISCH GRD CONDUCTOR
 - (E1) TO BDFB GRD BUS
 - (E2) TO BAT. CONT BD. GRD BUS
- (F) 350MCM RR GRD BOND
 - (F1) TO MAIN AIS GRD EQLR
 - (F2) TO CO GRD EQLR
 - (F3) TO FLOOR CO GRD BUS
 - (F4) BETWEEN 1/4 X 1 GRD BUS
 - (F5) JUNCTION (D) NOT APPLICABLE
 - (F6) TO ADDED 1/4 X 1 GRD BUS MTD ON REAR OF FRWK WHEN EQPT PROHIBITS FRONT MOUNTING
- (G) FILTER OR FS PNL WITH GRD STUD OR BUS MTD ON BAY, INDIV BAT. AND GRD SUPPLY
- (H) NO. 6 GRD BOND
 - (H1) TO RR, NOT E/W GRD BUS
 - (H2) TO STUD OR GRD BUS OF UNIT MTD PER (G)
 - (H3) TO DUCT BAY LINE 1 IN. PIPE
- (J) 750MCM MAIN AIS GRD EQUALIZER
 - (J1) TO OTHER RR LINES
 - (J2) TO BDFB GRD BUS
 - (J3) FOR RR LINES ON BOTH SIDES OF MAIN AISLE
- (K) 750MCM CO GRD HORIZ EQLR
 - (K1) TO CO GRD BUS
 - (K2) TO OTHER MAIN AIS GRD EQLR AND/OR BDFB GRD BUS
- (L) NO. 2 GRD BOND
 - (L1) TO OTHER FRAME LINES REQUIRING FRAME GROUND
- (M) GRD BOND AS REQUIRED
 - (M1) TO MISC FRWKS, CABS, ETC. IN VICINITY REQUIRING FRWK GRD.

Fig. 1—Typical Manual Toll Combined Discharge-Framework Ground Systems