STRAPPING
GENERAL METHODS AND REQUIREMENTS

CONTENTS

1. GENERAL

1.1 Scope of Section

1.11 This section covers the general requirements, methods and related information for wiring designated by word or convention on the wiring diagrams as "strapping". It does not include strapping associated with cross-connections which are covered in the 500 series of this handbook.

1.2 Precautions Against Personal Injury, Equipment Damage and Service Interruptions

1.21 The specific precautions to be taken against personal injury, equipment damage and service interruptions are in this section with associated methods. Refer to Handbook 0 for general precautions that are to be observed at all times.

2. INSTALLING EQUIPMENT

2.1 Tools

R-4108	Cutter, Midget, Diagonal
R-4544	Cutter, Diagonal, Wire Retaining
R-3304	Cutter, Strap Wire
R-3007	Copper, Soldering, Lightweight (60 Watt)
R-4121	Soldering Station, Temperature Control (60 Watt)
R-2733	Copper, Soldering, (110 Watt)
R-2972	Tip, Soldering Copper, Iron Clad
R-3949	Tip, Insulated, Soldering, Aluminum Oxide Coated
R-4104	Tip, Soldering, Iron Clad (For R-4121 Iron)
R-4463	Tip, Soldering - 2 3/4" long with 90° bend at end
R-4464	Tip, Soldering - 1/8" wide by 2 5/8" long (R-2733)

R-2735 Tip, Soldering - 1/2" wide by 4" long (R-2733)
R-2793 Tip, Soldering - 1/2" wide by 2 3/8" long (R-2733)
R-2741 Tip, Soldering - 7/32" dia. by 1 13/16" long (R-2789, R-2733)
R-2889 Tip, Soldering - 7/32" dia. by 2 1/16" long (R-2789, R-2733)
R-4368 Tip, Soldering, Long Spade (R-4121)
R-2789 Adapter, Tip, Soldering Copper (R-2733)
R-4361 Wrapping Tool, Continuous Bare Wire (Pneumatic)

2.2 Supplies

Wire, Strapping, Adjacent Terminals (Formed)

P-202893 9/32" Terminal Spacing (5 1/2" long)
P-202894 11/32" Terminal Spacing (6 5/8" long)

Wire, Copper, Tinned, Insulated (Solderless Wrap)

R-10 24BW, Precut and Preskinned (1 5/8" at each end)
R-11 26BY, Precut and Preskinned (2" at each end)
R-12 26BW, Precut and Preskinned (2" at each end)
R-800 24BU, Precut and Preskinned (1 5/8" at each end)

Wire, Copper Tinned, Bare (Spools)

P-146465 No. 18 Gauge (1 lb. - 203 ft.)
P-146467 No. 20 Gauge (1 lb. - 323 ft.)
P-46E728 No. 22 Gauge (1 lb. - 510 ft.)
P-46E729 No. 24 Gauge (1 lb. - 820 ft.)

Wire, Copper, Tinned, Insulated (Spools)

P-26997 No. 18 Gauge Type-J Black (100 ft.)
P-311746 No. 20 Gauge Type-J Black (100 ft.)
P-26991 No. 22 Gauge Type-J Black (100 ft.)
P-46A567 No. 24 Gauge Type-BU Black (100 ft.)
P-46B054 No. 24 Gauge Type-BW Green (500 ft.)
P-46B056 No. 24 Gauge Type-BW Black (100 ft.)
P-46B059 No. 24 Gauge Type-BW Red (200 ft.)
P-46B697 No. 26 Gauge Type-BW Green (500 ft.)

Wire, Copper, Tinned, Bare (Solderless Wrap)

R-8000 No. 24 Gauge, Precut and Prebent for Strapping Adjacent Terminals Spaced on 1/4" - 3/8" Centers

3. DEFINITION OF TERMS

3.01 BANJO STRAPPING: Bare wire which is run directly from terminal to terminal usually on crossbar switches, marker connector relays, etc.

3.02 BARE STRAP: A strap made of bare tinned wire.

3.03 BASE STRAP: A strap placed on a terminal strip approximately 1/8 inch from the base of the terminal to avoid interference with the dress of other wiring when straps are run at right angles.

3.04 COMMON STRAP: A continuous piece of wire which connects one or more terminals within an individually numbered circuit to terminals on succeeding or preceding numbered circuits for the purpose of supplying battery, ground or other common potential to the components or to serve as a common wire for testing, listening, ringing, etc.

3.05 COMMON WIRE: Any wire supplying battery, ground, ringing, tone, etc. to more than one component. The connections between the several components are made by means of common straps or loop wires.

3.06 EXTENDED SKINNER: A connection between adjacent terminals which is established by extending the bare wire end terminating on one of the terminals to the next terminal in line in order to avoid the use of a separate strap or loop.

3.07 FORMED STRAPS: Straps that are formed at each terminal to which they are to be connected, in such a manner so as to clear other terminals or to provide a greater soldering surface.

3.08 INDIVIDUAL STRAP: Straps that connect two or more terminals together in the same individually numbered circuit for the purpose of supplying battery, ground or other common potential to components or to serve as a common wire.

3.09 LOOP LEAD OR WIRE: An insulated common wire run from terminal to terminal of the same or adjacent components and sewed into the cable form instead of being run directly from terminal to terminal.

3.10 MULTIPLE STRAPPING: Bare wire strapping (banjo straps) runs straight and connects in the soldering notches of crossbar switches, 286, 287 and similar type multicontact relays. At 286 type relays, in general, piece part coded strap wire assemblies with molded plastic separators between each relay position is used.

3.11 SLEEVED STRAP: A strap made of sleeved wire.

3.12 STRAIGHT STRAP: A strap that is run directly between two or more terminals without bends or offsets and is usually used for strapping adjacent terminals or terminals with connecting notches.

3.13 STRAP: The term strap, is applied to a form of direct wiring used for connecting apparatus terminals, where the use of local cable or other forms of wiring would be too cumbersome because of congestion. Straps are also used for extending connections such as battery, ground, etc., or to make repetitive or other type connections on the same or through closely associated similar apparatus.

3.14 SURFACE STRAPPING: Strapping (soldered type) placed in the soldering notches or near the outer ends of terminals on terminal strips to facilitate subsequent rearrangements of optional strapping. This strapping is identified by the convention "SS" on the associated wiring diagrams.

4. TYPES OF WIRE USED

4.1 Wire Codes

4.11 Straps may be either bare or insulated wire, depending on the clearance between the straps and other terminals or uninsulated metalwork, and the distance between the points of connection.

4.111 For apparatus with terminals requiring strapped soldered connections, insulated straps shall be used as follows:

(1) Type "BW" is general usage wire - used for local cables, loose wiring, surface wiring and cross connections

(2) Type "J" is used for General Strapping applications where pushback insulation is required.

(3) Type "AM" is used for locations where wire is subject to mechanical damage and where additional insulation strength is required.

(4) Type "BH" is used for network wiring in place of "AM" wire when a high grade of insulation is required.

(5) Type "DM-1" is used mainly in "R-type" switchboard cable. This is a (IPVC) insulated wire.

(6) Bare tinned solid wire sleeved with fiberglass sleeving per KS-7851 L-3, or equivalent.

4.112 For apparatus with terminals approved for solderless wrap connecting, insulated wire of the following types may be used.

(1) Type "Y" wire is PVC insulated and used primarily as cross-connect wire.

(2) Type "BU" wire is PVC insulated and used primarily as local cable wire.

(3) Type "BY" wire is PVC insulated and used as local cable where moisture-proofing is required.

(4) Type "DM-1" wire is IPVC insulated and used primarily in R-type switchboard cable. However, it will be used as a surface wire in the very near future.

(5) Type "DT" wire is IPVC insulated and used as distributing frame cross-connect wire.

(6) Type "DP-2" wire is IPVC insulated and used as cross-connect wire.

(7) Type "DY" wire is IPVC insulated and used primarily as cross-connect wire on 66-type connecting blocks which have quick-connect terminals. This type of wire is not normally used for soldered or solderless wrapped terminations.

4.113 In general the kind of wire (insulated or bare) required shall be determined in accordance with the following. However, exceptions specifying the application of bare wire which may not be in accord with the following clearance requirements should be specified on the associated drawing.

Separation Between Points of Connection	Kind of Wire	
	Bare	Insulated
Over 1"	Clearance 3/4" or more	Clearance less than 3/4"
Over 1/2"	Clearance 1/4" or more	Clearance less than 1/4"
1/2" or less	Clearance 1/16" or more	Clearance less than 1/16"

4.2 Wire Gauges

4.21 The standard wire sizes used for strapping purposes are as follows:

(a) No. 16 gauge or larger should be used where the leads connecting to the apparatus are No. 16 gauge or larger. In general, the strap should be the same size as the connecting lead unless there is obviously no need for so much current carrying capacity, in such case the wire size should be shown on the associated wiring drawing.

(b) No. 18 or 20 gauge wire is used where the mechanical strength and stiffness of the strap is necessary to insure adequate separation between the straps and other terminals or metal parts. It is generally used as follows:

1) Bare formed straps between nonadjacent terminals.

2) Bare straight straps serving an entire mounting plate.

3) Insulated straps may be used for either straight or formed strapping.

(c) No. 22, 24 or 26 gauge, bare or insulated wire is used for strapping between terminals on the same piece of apparatus or between terminals on adjacent pieces of apparatus within the same circuit.

5. ARRANGEMENT OF STRAPS

5.1 Straps should be run directly from terminal to terminal and should meet the following requirements:

(a) Allow access to the wiring terminals of other parts of the apparatus.

(b) Avoid interference with the operation of the apparatus.

(c) Allow removal of apparatus for maintenance, modification, or inspection purposes.

(d) Avoid obscuring designations.

6. POSITION OF INSULATION

6.1 Soldered Connections: The insulation of straps should extend close to the point of soldering but should be excluded from the holes of perforated terminals (when permitted) and from the notches of notch-type terminals. No insulation should appear on the soldered side of the connection thereby eliminating the possibility of a poor connection.

6.11 The bare portion of the wire between the point of soldering to the terminal and the insulation of the wire should not be longer than the clearance between adjacent terminals at that point and no longer than 1/8 inch.

6.2 Solderless Wrap Connections: The bare portion of the wire between the point of connection to the terminal and the insulation of the wire should be less than half the distance between adjacent terminals at that point and in no case longer than 1/8 inch.

6.21 Wires should not be drawn taut around terminals to which they do not connect. This is necessary to prevent the possibility of insulation breakdown and to minimize strain on the terminals.

7. INSULATED STRAPS

7.1 Insulated straps shall be run to meet the requirements of Paragraphs 5.1, a through d.

7.11 Except for types "BW", "DT", "DM-1" and "DP-2" wire, the straps should not rest against any network other than the terminals to which they are connected. In cases where straps are dressed between rows of terminals with relatively close spacing, as usually encountered on terminal strips, relays, or bifurcated terminals (two prong) such as the magnet terminals of crossbar switches, the straps may touch other terminals. However, in no case shall any straps be dressed across the edges of terminals so tightly as to result in pressure between the wire and terminal which could result in insulation breakdown.

7.12 Type "J" wire has the loose push-back insulation and, therefore, it is not always possible to meet the "no longer than 1/8 inch shinner" requirement on short and/or straight formed straps. In such cases, the insulation should extend as close to the terminal as possible to prevent other terminals or bare wire from coming in contact with the bare portion of the "J" wire strap. This type of wire should not rest against uninsulated metalwork or other terminals wherever possible.

8. USE OF LOOP LEADS

8.1 Use loop leads (rather than straps run from strip to strip) for apparatus such as relays, jacks, lamp sockets and keys mounted on several strips or mounting plates. Where separate terminals for the termination of common leads are provided on the mounting plate, loop leads should not be used but the common lead should be run directly from mounting plate to mounting plate.

8.11 Use loop leads instead of straps for common ringing leads between pieces of apparatus in one mounting plate, except where the apparatus served is located on close centers (such as, 18 or 19 type resistors on 1/2 inch centers). In these latter cases, straps shall be used.

8.12 Loop leads shall be used instead of straps where congestion resulting from excessive straps or where insulation requirements prohibit the use of type "J" wire, such as for leads that carry potentials exceeding 48 volts, except under conditions as covered in Paragraph 8.11.

9. STRAPPING SURFACE WIRED UNITS

9.1 On surface wired (SW1 or D3 wiring) equipment units, strapping shall be limited to connections made with bare wire or with extended skinner connections and to apparatus equipped with strapping terminals (A, EA-, and similar type relays). All other connections should be made as surface wire.

9.2 On apparatus or groups of apparatus, such as keys, jacks, tenite assemblies, and resistor mounting boards, where the points of termination are a considerable distance from the mounting plate or panel, it is sometimes impracticable to dress the wiring between the terminals back against the mounting plate. In such cases, it will be satisfactory to run the wiring in the same manner as would be used for standard strapping.

10. CONNECTING STRAPS

10.1 Individual Straps: May be connected with a pair of plier or may be solderless wrapped. When they are solderless wrapped they shall meet the requirements of Section 310 of this handbook.

10.2 Plier Connected: Wire terminations are generally made with a simple half-wrap around the terminal. However, it is permissible to use a full turn or maximum of 1-1/2 turns of bare wire around the terminal. The following connections may also be utilized:

(a) A simple hook connection made through the hole of the terminal. An individual strap may be connected in back of the hole in the terminal or passed through the hole in the terminal providing there is no interference with the connection or removal of other wiring. Both ends of the strap should either be connected in back of the hole or through the hole.

(b) An extended skinner connection may be made between two adjacent terminals or to the next terminal in line on the same piece of apparatus. When this method is used, the continuation of a skinner lead should be run through the hole of the first terminal and then wrapped around the first and second terminals as shown in Figure 1.

Where adjacent terminals are so close that they can easily be drawn and held together, they may be connected to and soldered as one terminal. Care should be taken to insure that both terminals are securely soldered by filling the holes in both terminals with solder.

10.21 Closely adjacent thin flexible terminals may be soldered directly together instead of being strapped providing no other wiring or strap is to be connected to these terminals. The terminals should be wrapped and in contact with each other before soldering. Do not bend terminals so they interfere with other terminals.

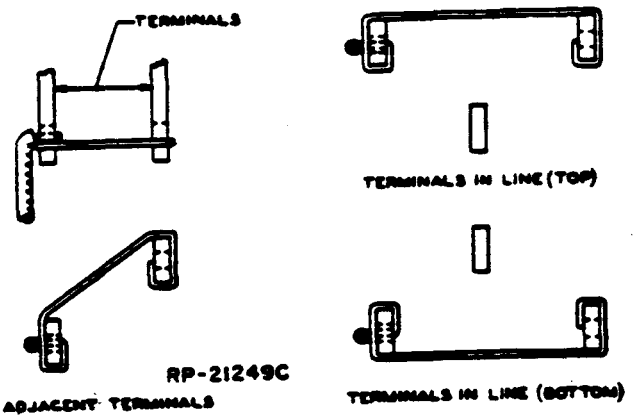
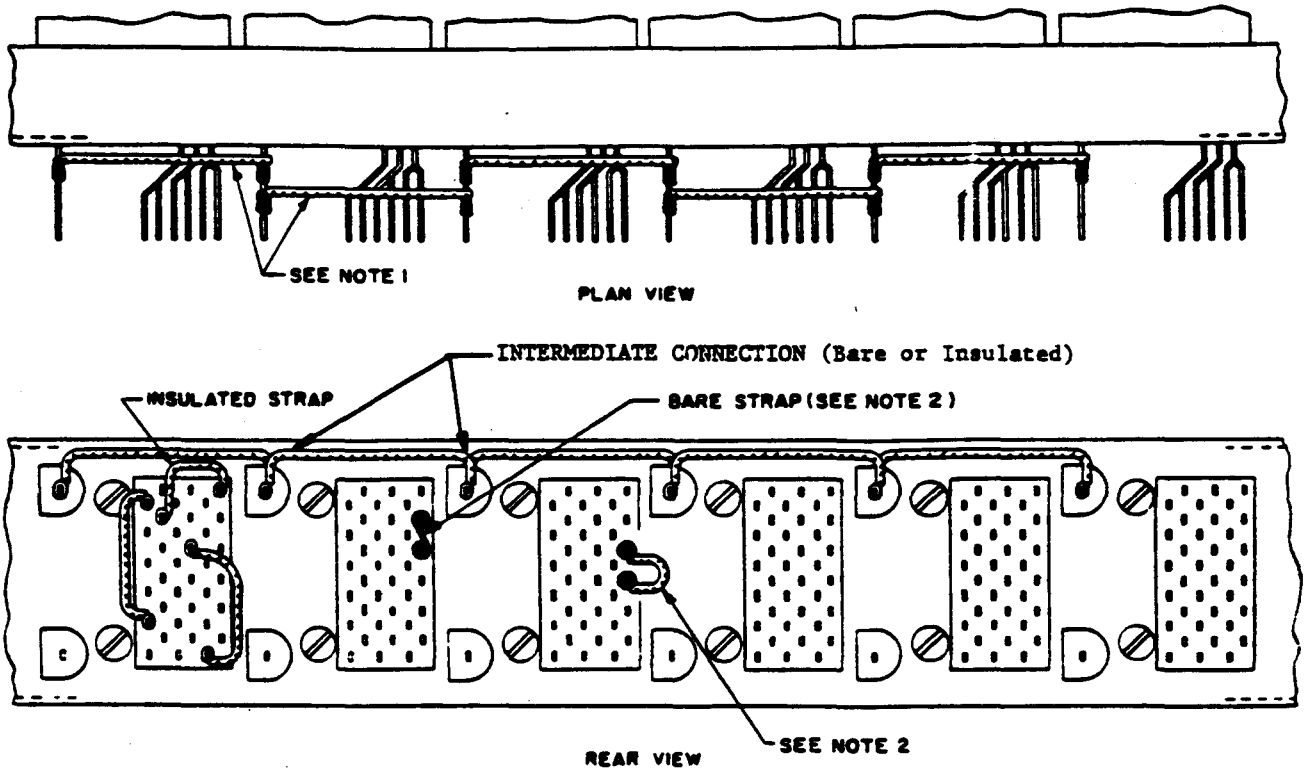


FIG. 1 CONNECTING CONTINUATION-OF-SKINNER (PAR. 10.2b)

10.3 Common Strap: Connections are made in a manner that will permit removal of the strap without affecting its continuity. This type of strap is generally made with a simple half wrap or one full wrap of bare wire. These straps should not be run through the holes of perforated terminals because it would be impossible to prevent breaking continuity if a center terminal had to be removed.

10.31 Where adjacent terminals on the same piece of apparatus are to be connected to the common strap, the common strap may be formed around the two terminals and connected as if it were one. Care should be taken to insure wire is securely soldered to both terminals.

10.32 Common strap Intermediate Connections may also be made as a formed loop of bare wire or laid directly across the flat side or edge of the terminals and soldered.



NOTES:
1. ARRANGEMENT OF STRAPS WHEN FOUR OR MORE TERMINALS ARE CONNECTED IN COMMON.
2. ALTHOUGH USE OF BARE STRAPPING IS PERMISSIBLE, INSULATED STRAPS ARE RECOMMENDED TO FACILITATE APPLICATION AND AVOID INTERFERENCE.

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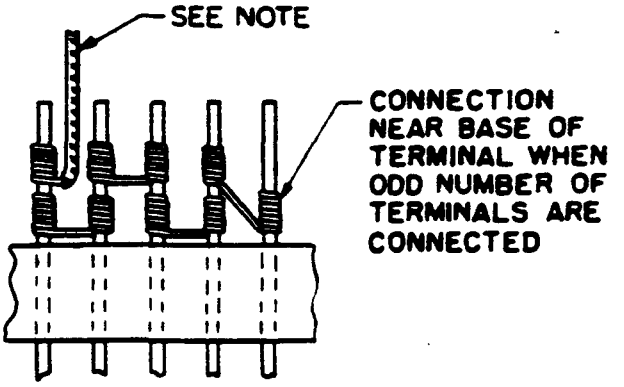
FIG. 2 STRAPPING FOUR OR MORE TERMINALS, RELAYS (PAR. 10.5, 12.111)

10.4 Connecting Loop: A loop in a common strap may be utilized when a strap serves apparatus in more than one circuit. The purpose of the loop is to provide continuity of service over the common strap when a piece of apparatus or circuit is being removed from the group. The loop is not necessary when a separate terminal is provided for terminating the incoming lead or strap. A strap loop is not required, however, it does facilitate connecting feeder and loop leads.



NOTE:
WHEN SURFACE STRAPPING IS SPECIFIED CONNECT THE INCOMING LEAD AT BASE OF TERMINAL AND USE A SIMILAR STRAPPING ARRANGEMENT.

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FIG. 3 STRAPPING FOUR OR MORE TERMINALS, TERMINAL STRIPS (PAR. 12.111)

10.5 Intermediate Connections: Intermediate connections that are plier connected should be made by wrapping one complete turn of bare wire around each terminal. This type of connection can be accomplished by utilizing a bare wire formed loop or a continuous insulated strap (refer to Figure 2).

10.51 Intermediate connections can also be applied by using a straight bare wire laid straight and flat across the edge or flat side of the terminals. (Banjo Wire Strap)

11. EXTENDING COMMON STRAPS

11.1 Where apparatus positions are equipped in consecutive order, straps should be of sufficient length to reach only the equipped apparatus. When apparatus is added, disconnect the strap from the apparatus at the last equipped position and extend it by means of a straight splice between the last two pieces of the original apparatus.

11.11 Where flat type resistances, or other closely spaced strip mounted apparatus is added, and it is impracticable to extend the common strap by means of a straight splice as specified in the preceding paragraph, connect a separate piece of strap wire to the strapped terminal of next to the last piece of apparatus in the original equipment, extending it to the last piece of apparatus in the original equipment, and to the added apparatus in the prescribed manner. The strap wire should be of the same size and type (insulated or bare) as the original strapping and should be connected to the strapped terminals of the original apparatus between the original strapping and the mounting plate.

11.12 On terminal strips where additional terminals are to be strapped, extend the common strap by connecting a separate piece of strap wire to the last strapped terminal and to the added terminals in the prescribed manner. The strap wire should be the same size and type (insulated or bare) as the original strapping.

11.2 Where the apparatus arrangement is irregular with intervening unequipped positions, form the straps for the intervening unequipped apparatus positions and protect the bare portion of the straps with tape. The straps should not be formed or run beyond the last equipped apparatus position, but should be spliced out in the normal manner when the apparatus is added.

11.3 Straps should be supported at every second and end unequipped apparatus positions by tying with a single strand of twine to, but not directly against the mounting plate. Where an apparatus position is unequipped at both sides of the loop in the strap for connecting common leads, the strap should be supported at both unequipped positions.

12. STRAPPING SOLDERLESS WRAP TERMINALS

12.1 Connecting Methods

12.11 Wire wrap strap connections shall be made in accordance with the connecting requirements as covered in Section 310. Straps should be placed on terminals before other wiring is connected unless otherwise specified for optional wiring arrangements which are subject to change. Optional wiring arrangements are usually designated by the convention "SS" (surface strapping) or other reference on the associated wiring diagrams.

12.111 When four or more terminals are interconnected by means of strap wire (insulated or bare), the wire ends should be connected so that a minimum number of wires need be disconnected when future changes are made in the grouping of the terminals or when a piece of apparatus is to be replaced. For example, Figures 2 and 3 illustrate such arrangements.

13. VERIFICATION

The following is a list of verification items and a brief statement concerning the requirement.

VERIFICATION ITEM AND BRIEF STATEMENT OF REQUIREMENT	REFERENCE	
	PARA.	FIG.
13.01 Use correct wire code for strapped soldered connections	4.111	
13.02 Use correct wire code for solderless wrap connections	4.112	
13.03 Use bare or insulated wire depending on the distance of separation between termination points	4.113	
13.04 Use correct wire gauge for strapping	4.21 a,b,c	
13.05 Straps meet the following requirements a) Allow access to wiring terminals b) Avoid interference with operation of apparatus c) Allow for maintenance, removal and inspection d) Avoid obscuring designations	5.1	
13.06 Wire insulation positioned correctly for a) Soldered connection b) Solderless wrap connections	 6.1 6.2	
13.07 Insulated straps to meet requirements of item 13.05	7.1	
13.08 Except for "BW, DT, DM-1 and DP-2" coded wire, the straps should not rest against any foreign networks	7.11	
13.09 "J" wire straps should not rest against uninsulated metalwork or other terminals	7.12	
13.10 Run loop leads between strip mounted apparatus	8.1	
13.11 On SW units, strapping shall be limited to connections made with bare wire or extended skinners	9.1	
13.12 Plier connection made with 1/2 - 1-1/2 turns around the terminals	10.2	
13.13 Simple hook connection made in back of, or through the the hole. No interference with other wiring	10.2a	
13.14 Extended skinner connection made between adjacent terminals run through hole of first terminal and then wrapped around both terminals	10.2b	
13.15 Thin flexible terminals can be drawn together then wrapped and soldered	10.21	
13.16 Common strap connections shall be made in a manner so apparatus removal does not affect continuity	10.3	
13.17 Common straps must be securely soldered to both terminals	10.31	

VERIFICATION ITEM AND BRIEF STATEMENT OF REQUIREMENT	REFERENCE	
	PARA.	FIG.
13.18 Intermediate connections made by wrapping one turn of bare wire around each terminal	10.5	2
13.19 Intermediate connections can be made by laying straight across flat or edge of terminals (banjo strap)	10.51	
13.20 Extend common straps by disconnecting and splicing between the last two pieces of original apparatus	11.1	
13.21 Extend common straps on closely spaced apparatus by connecting a separate strap to the next to last piece of existing apparatus and extend to added apparatus.	11.11	
13.22 Extend common straps on terminal strips by connecting to last terminal and extend to new terminals	11.12	
13.23 On irregular strapped apparatus the bare wire passing unequipped locations may require protection	11.2	
13.24 Unequipped apparatus locations - Support at every second and end locations with twine	11.3	
13.25 SW connection meet requirements of Section 310	12.11	
13.26 SW strap connections placed before other wiring	12.11	
13.27 SW straps placed so minimum amount of connections be disturbed during strap removals (4 or more)	12.111	2,3

No arrows due to complete revision.

Vertical line at side of paragraphs indicate requirements.

Engineering Planning Manager
(Installation)

Reason for reissue:
Completely revised and to include verification items within section.