

WIRING
GENERAL

CONTENTS

- | | |
|---|--|
| <p>1. INDEX</p> <p>2. GENERAL</p> <p> 2.1 Scope</p> <p> 2.2 Definitions</p> <p> 2.3 Job Information</p> <p> 2.4 Cautions</p> <p> 2.41 Against Personal Injury</p> <p> 2.42 Against Equipment Damage</p> <p> 2.5 Tagging Wires</p> <p> 2.6 Temporary Guard - Switch Assembly</p> <p>3. INSTALLING EQUIPMENT</p> <p> 3.11 Tools</p> <p> 3.12 Supplies</p> | <p>4. COMMERCIAL WIRE</p> <p>5. ARMORED CABLE KS-5497-01</p> <p>6. SWITCHBOARD TYPE WIRE AND CABLE</p> <p>7. LEAD AND PLASTIC COVERED WIRE</p> <p>8. WIRE PROTECTION - PERMANENT</p> <p>9. CODE REQUIREMENTS</p> |
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1. INDEX

Subject	Figure	Paragraph
Cable and Wire		
Armored Cable		5.
Commercial Wire		4.
Current Capacity	Table A	4.1
Lead and Plastic Covered		7.
Measuring Size of Wire		2.53, 4.2
Power Wire		2.203
Run Before Connecting		2.427
Switchboard		6.
Cautions		
Against Equipment Damage		2.42
Against Personal Injury		2.41
Definitions and Descriptions		
Armored Cable KS-5497-01		2.202
Accessible for Inspection		2.201
Cable		2.203, 2.205
Charge Conductors		2.207
Discharge Conductors		2.208
Filament		2.204
KS-5482-01 Wire	Table A	2.203, 4.1
Paired Conductors		2.209
Plate & Filament Leads		2.204
Service Leads		2.210
Signaling Conductors		2.211
Singly Run Conductors		2.212
Sleeves		2.213
Telegraph Conductors		2.214
Wire		2.203, 2.206
Dummy Fuses		6.3
Guards - Temporary - Switch Assembly	3	2.6
Job Information		2.3
National Electrical Code		2.3, 9
Supplies		3.12
Tagging Wire	1,2	2.5
Tools		3.11
Underwriters Certificate		9.3
Unequipped Circuits		6.2
Wire Protection		8.

2. GENERAL

2.1 Scope

2.11 This section contains general information pertaining to cabling and outlines the application of the National Electrical Code (N.E.C.). It defines the various classes of leads and their use.

2.12 Specific operations such as supporting, running, bending, forming, pairing, verification, etc., are covered in other sections in the 6 series.

2.2 Definitions

2.201 The term "Accessible for Inspection," deals with the accessibility of solderless connections. Operating company maintenance routines require that they be periodically checked for tightness.

2.202 "Armored Wire and Cable" (KS-5497-01) consists essentially of commercial power wire enclosed in a flexible metallic armor. The conductors are type "RH-RW" or "RHW" with heat and moisture resistant insulation and rated at 600 volts. The conductors are helically wound with a form of tape and flexible armor. Sizes range from No. 14 to 500 MCM. Between the wire assembly and the armor, in sizes No. 14 through No. 1 A.W.G., a bonding wire is frequently provided.

2.203 "Power Wire and Cable" (KS-5482-01) is an Underwriters' Laboratory approved commercial grade building wire with several alterations for system use. The principal differences from usual commercial wire are use of a light gray finish, starting of stranding with No. 8 instead of No. 6, and marking of KS designation on the wire. This wire is made in sizes No. 14 to 750,000 cm A.W.G. The types most often used in the telephone office may be either "RH-RW" or "RHW" and has either a braided or knitted covering. "RH-RW" identifies heat resistant rubber rated at 75°C and water resistant rubber rated at 60°C. "RHW" is similarly heat and water resistant rubber but rated at 75°C. Special types of power wire and cable also provided under this KS specification are Duplex conductors (RHD-RWD), Multiple 3 or 4 conductors (RHM-RWM), and Lead covered conductors (RHL-RWL), (RHDL-RWDL) or (RHML-RWML).

2.204 "Plate" and "Filament" leads are those connected between the filter on one end and the plate and filament load on the other. Unfiltered leads used for filament and plate supply are treated as signal conductors.

2.205 "Cable" is an assembly of two or more conductors insulated from each other.

2.206 "Power Wire" is a single conductor whether solid or stranded and regardless of size.

2.207 "Charge Conductors" are those between charging units and the battery or the point at which discharge conductors connect.

2.208 "Discharge Conductors" are those that carry discharge current to the office equipment from the battery and Counter Electro-Motive Force Cells (CEMF).

2.209 "Paired Conductors" are conductors of opposite polarity of a given circuit run close together (but not necessarily twisted) so that the interlinking magnetic fluxes from currents in opposite directions neutralize each other. Three conductors (ground, 24 volts and 48 volts) are considered paired if run close together.

2.210 "Service Leads" are used to designate primary current supplies from outside power service or an alternator set, up to power converting or consuming devices. Note that this usage is broader than the technical N.E.C. usage where "service leads" terminate at the building service panel from which "feeders" and "branch circuits" are run to telephone power plants, lighting panels and electrical equipment generally.

2.211 "Signaling Conductors" are those comprising the bulk of power supply leads to telephone equipment. Included are leads supplying unfiltered battery, ground, certain types of ac, interruptions and ringing, tones, etc., from ringing supply equipment.

2.212 "Singly Run Conductors" are those not paired with a conductor carrying current in the opposite direction and of the same circuit.

2.213 "Sleeves" are conduit nipples or short lengths of conduit or smooth iron pipe free from burrs, or fiber duct. They are frequently used to protect cables or wires passing through walls or floors.

2.214 "Telegraph Conductors" are those carrying current to telegraph or teletypewriter equipment.

2.3 Job Information

2.31 Job information covering power wiring should insure that the completed product conforms to the National Electrical Code. However, in special cases reference to the code may be advisable. It is, therefore, recommended that each installer be familiar with the code requirements and that a copy be available. Copies of the National Electrical Code should be obtained from the Western Electric Company, Incorporated, Installation Distribution - Level A, 222 Broadway, New York 38, N.Y. Special requirements of a Local Code which are more exacting than the National Code will be covered in the job information or specifically mentioned by the telephone company's representative at the time of installation.

2.4 Cautions

2.41 Against Personal Injury

2.411 When handling lead covered or armored wire and cable, use gloves and avoid putting hands to sensitive areas on the head. Wash hands thoroughly after handling to remove contaminant.

2.412 When necessary to run lead covered or armored wire and cable at or above eye level such as in shaftways, etc., always wear R-3055 All Plastic Safety Goggles.

2.413 When running power wire and cable, make sure floor is free of dirt, oil drippings, debris and other obstructions. Ascertain firm footing when pulling or feeding wires from floors, ladders, etc. Avoid twisted or off-balance positions.

2.414 No attempt shall be made to pull leads into a conduit while standing on a light structure or unstable platform. Platforms such as those built under pull boxes near the ceiling should be approved by the supervisor responsible for such operations. If possible, stand on dry floor areas, clear of movable objects which can interfere with pulling-in operations. Anticipate at all times that a rope may break, or that immediate slack may be placed on the pulling rope due to sudden release movements of the cable in the conduit following a steady strain. This could result in injury if the individual were suddenly thrown off balance. Keep all slack out of the pulling rope by applying a steady pull, not a series of jerks.

2.415 When running power wire in shaftways or through slots, provide temporary closure for protection against drafts and falling objects until such time that permanent covers can be secured. Follow the practices given in the Cabling Handbook.

2.416 The cut ends of power wire & cable and armored wire & cable very often have sharp projections. To prevent personal injury always tape the ends before handling. See Section 6B.

2.42 Against Equipment Damage

2.421 When working close to live equipment cover metallic tools with approved insulating material in such a way as to reduce likelihood of short circuits to a minimum.

2.422 During the installation period cover cables or wires on horizontal racks near the floor at the rear of power panels. This is necessary to insure that they will be protected against falling material or being damaged if accidentally stepped on. Protect cable and live equipment from physical damage or short circuit by using appropriate insulation such as paperboard, masonite, sheet fiber, and protective sheeting.

2.423 When running armored wire and cable near live bus bars, the live bus bars must be temporarily protected with some rigid insulating material such as heavy paperboard or masonite. This protection shall be securely held in place so as not to be disturbed when struck by the armored wire and cable.

2.424 Observe cautions in using wire and cable reels as covered in Section 6B.

2.425 Bends shall be so made and other handling such that the protective coverings of the wire will not be injured.

2.426 On cable racks above or near live equipment, or equipment which may be made live before the cables are permanently secured to the racks, secure armored cables temporarily with No. 48 twine in such a manner as to prevent their coming in contact with the live equipment. Where additional armored cables are to be run to a live power board, first, strip the armor to the required length for the power board end. Where feasible, run the cable or wire from the distant end toward the power board and secure the butts at the proper point. Secure the cable starting at the power board end and progressing to the distant end.

2.427 Run and secure all leads before connecting.

2.5 Tagging Wires

2.51 Wires are tagged for identification purposes as they are run in. The tags are placed at both ends far enough from the ends of the wire so that they do not have to be moved when the wire is skinned. The SD4-218 cable tag and the method of tying it to the wire is illustrated in Figure 1.

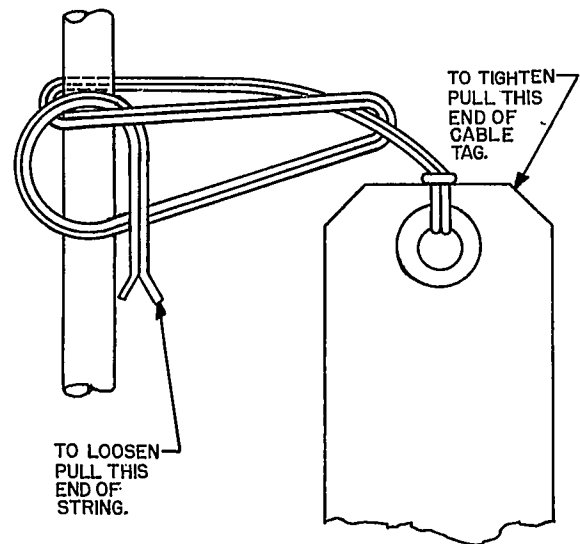


FIG. 1 SD4-218 CABLE TAG AND METHOD OF TYING (PAR. 2.51)

2.52 The 145C number plate as covered in the numbering and lettering information may be used to permanently designate a power lead. It consists of a small fiber tag joined to a brass ring. Use No. 12 twine in tying the plate to the wire as illustrated in Figure 2.

2.53 Identify usable lengths of wire removed from reels and cartons by tagging as to length and size.

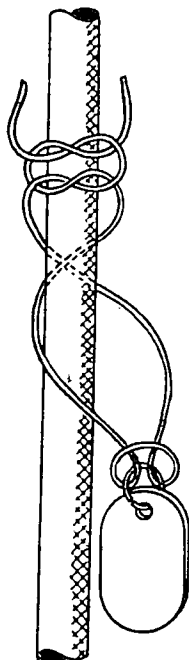


FIG. 2 145C NUMBER PLATE AND METHOD OF TYING (PAR. 2.52)

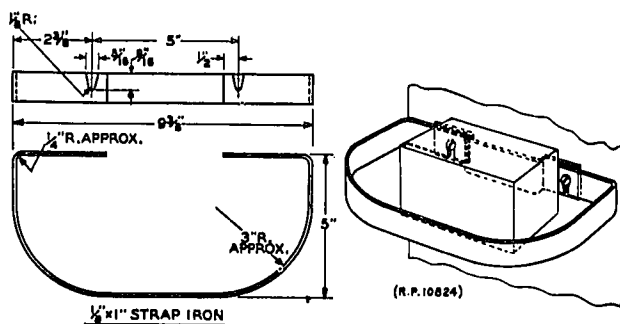


FIG. 3 TEMPORARY GUARD - SWITCH ASSEMBLY CABINET TYPE END GUARDS (PAR. 2.61)

2.6 Temporary Guard - Switch Assembly

2.61 When cabinet type end guards are provided the arrangement shown in Figure 3 may be used as a temporary guard for aisle lighting switch assemblies. (The permanent end guards are not installed until late in the installation period). The strap iron bands used as supports for frames to their shipping skids are satisfactory for these details.

3. INSTALLING EQUIPMENT

3.1 The tools and supplies required for operations covered in the series 6 sections are given in Paragraphs 3.11 and 3.12. By referring to the list of tools it will be seen that Kit No. 3 will be required on the average or larger jobs.

3.11 Tools

Code	Description	In Kit No.
→ ITE-4740	Insulation Test Set	
R-2062	Bracket, Cable Guide	49
R-1265	Brush, Flat, 2", Stiff	49, 102, 110, 119
R-1455	Clamp, C, 6"	3, 4, 22, 32A, 42, 49, 102, 145
R-2308	Drill, .120" - No. 31	3, 32, 32A, 42, 102
R-1620	Drill, Wheel	3, 32, 32A, 42, 102
→ R-3055	Goggles, Safety, All Plastic	4, 32, 32A, 36, 42, 43, 48, 55, 102, 145, 162
R-3143	Guard, Fuse Bay	-
R-2061	Guide, Cable	49
R-1497	Hoist, Rope, Self-Locking	4, 43, 48, 55, 162
R-2559	Lamp, Test, Power	3, 32, 32A, 102
R-3195	Lift, Reel, Power Wire	
R-3209	Needle, Cable Sewing	32, 32A, 42, 102
284	Needle, Chicago	32, 32A, 42, 102
R-2195	Pliers, Side Cutting, 8"	3, 49
R-2727	Reel, Cable	
KS-8047	Reel, Wire	
R-2542	Remover, Clip, Cable	42, 102
R-7850	Rope, 3/4" - one 150 ft. Length	
R-2281	Saw Frame, Hack, 10" and 12"	3, 4, 5, 32, 32A, 55, 102, 145
R-1615	Set, Jack, 29"	
→ R-3139	Set, Power Wire Brake	
R-1514	Shears, Cable	32, 32A, 42, 55, 102
R-3154	Sheeting, Protective	
→ R-3409	Dispenser, Coil Cable	
R-2118	Strap, Trunk	3, 49
R-2704	Support, Cable Reel	
R-2588	Wire, Fish	5, 21, 49
R-3371	Shear, Power Wire	3
→ R-3662	Cutter, Steel Strapping, Safety	43, 48, 55, 102

3.12 Supplies

Code	Description
→ SD4-218	Cable Tag
RM-626122	Canvas, Flameproofed
R-3269	Clip, Wire Form 1/16" Dia.
R-3270	" " " 3/32" Dia.
R-3271	" " " 1/8" Dia.
R-3273	" " " 3/16" Dia.
R-3274	" " " 1/4" Dia.
R-3275	" " " Adjustable 5/16" to 1/2"
R-3276	" " " Adjustable 5/8" to 1"
R-3277	" " " Adjustable 1-1/8" to 1-1/2"
R-3045 and 3046	Connector, Wire

Code	Description
Obtain Locally	1/2" Dowel Rod, Wood (#5 Crossbar Jobs)
RM-591862	Fiber Sheet, Gray, 1/64"
P-41E562	Fiber, Tube, Split
P-41E563	Fiber, Tube, Split
P-41E564	Fiber, Tube, Split
RM-669152	Gloves, Cotton (In Kit 3, 49)
P-409474	Insulator
RM-644743	Lacquer, Cellulose Acetate
R-3327	Lubricant, Wire
Obtain Locally	Mat, Rubber
NBFU Pamphlet No. 70	National Electrical Code
R-3454	Paints, Shellac, Orange
RM-644153	Paint, Gray Cable Filler
Obtain Locally	Planking 2" x 10"
P-68616	Protector, Fiber
KS-7860	Spirits, Petroleum
RM-591127	Tape, Friction, 3/4"
542.4	Tape, Gummed
RM-591102	Tape, Rubber
R-2916	Twine, No. 12
RM-628645	Twine, No. 48
Obtain Locally	Wire, Iron, No. 12

4.-COMMERCIAL WIRE

4.1 Commercial standard 600-volt wire is used in service circuits. It may also be used in emergencies as a replacement for KS-5482-01 wire when specified by the Equipment Engineers. (See Table A.) In service circuits use solid wire for conductors No. 10 A.W.G. and smaller, and stranded for conductors larger than No. 10 A.W.G. except that solid conductor may be used for No. 8 if stranded is not available.

4.2 Where it is necessary to measure wire to determine the size, it is advisable to gauge the diameter of the bare copper since the over-all dimension may vary due to insulation variations. See Table A.

4.3 The National Electrical Code requires all branch circuit conductors passing within 3" of fluorescent lighting unit ballast be designed to operate at 194°F. RHH type wire is acceptable for this use. This is now covered by issue 5B of SD-81035. On all jobs where the wiring for frame and aisle lighting (receptables excluded) has not been started, use only RHH type wire in and through fluorescent lighting fixtures. If Black, White and Red 12 gauge RHH type wire was not provided, order indicated quantities on Installers' Requisition ID-156. When requesting RHH type wire per RM numbers indicate "Do Not Substitute". Orders should be identified with the following numbers:

RM-634404 - 12 gauge Black
RM-634406 - 12 gauge Red
RM-634410 - 12 gauge White

5. ARMORED CABLE KS-5497-01

5.1 KS-5497-01 armored cable is used in power service circuits and other circuits for power service to motors, rectifiers, for ringing and tone circuits, for plate supply and for frame and aisle lighting circuits.

5.2 Do not run armored cable in open cell battery rooms.

6. SWITCHBOARD TYPE WIRE AND CABLE

6.1 When switchboard cables are a part of the power plant refer to the requirement and method sections of the Cabling Handbook for information on handling this type of cable and wire.

6.2 When the fuse posts for the power fuses and associated alarm fuses are furnished for the ultimate circuit requirements, the alarm wiring between the fuse posts, when provided, shall be connected to the fuse posts and fuse studs for the unequipped circuits.

TABLE A

CURRENT CARRYING CAPACITY, WEIGHT AND DIMENSIONS OF KS-5482-01 COPPER POWER WIRE TYPE "RH-RW" AND "RHW" IN RIGID OR FLEXIBLE CONDUIT MAXIMUM 3 CONDUCTORS PER RACEWAY OR CABLE. SEE NOTES 1 AND 3. (PAR. 4)

SIZE AWG NO.	AREA IN CM	CURRENT CARRYING CAPACITY SEE NOTES 1 & 2 AMPERES COPPER	DIA BARE COND INCHES	RHW DIA OVER INS INCHES	RHW NET WEIGHT PER 1000 FT POUNDS COPPER
14	4,110	15	0.064	0.19	26
12	6,530	20	0.081	0.21	35
10	10,380	30	0.102	0.24	49
8	16,510	45	0.129	0.31	84
6	26,250	65	0.184	0.40	126
4	41,740	85	0.232	0.45	190
2	66,370	115	0.292	0.51	278
1/0	105,500	150	0.373	0.63	443
2/0	133,100	175	0.418	0.68	540
4/0	211,600	230	0.528	0.78	814
	350,000	310	0.681	0.98	1,310
	500,000	380	0.814	1.12	1,815
	750,000	475	0.998	1.34	2,700

STANDARD SIZES

SIZE AWG NO.	AREA IN CM	CURRENT CARRYING CAPACITY SEE NOTES 1 & 2 AMPERES COPPER	DIA BARE COND INCHES	RHW DIA OVER INS INCHES	RHW NET WEIGHT PER 1000 FT POUNDS COPPER
1	83,890	130	0.332	0.59	364
3/0	167,800	200	0.470	0.73	663
	300,000	285	0.630	0.93	1,139
	400,000	335	0.728	1.03	1,473
	600,000	420	0.893	1.23	2,177
	700,000	460	0.964	1.30	2,512
	800,000	490	1.031	1.37	2,848

NONSTANDARD SIZES

NOTE 1: The N.E.C. permits these ratings to be exceeded when wire is used for motor circuits. Fuses must be large enough to carry starting currents. Equipment Engineers will specify fuse capacities. For more than three conductors in a cable or raceway (wireways, conduit, etc.), refer to the National Electric Code.

NOTE 2: If average room temperature exceeds 30C (86F) or if more than 3 current-carrying leads are in same conduit, or if conductors are RH-RW and are to be used in damp locations, see National Electrical Code for reduced ampere capacities.

NOTE 3: For ampere capacities of conductors in free air such as temporary back-taps, see Handbook 22.

6.3 In enclosed locations dummy fuses need not be installed in power fuse clips except as necessary to retain fuse caps. In exposed locations dummy fuses shall be installed in all locations where regular power fuses are not installed and where regular power fuses are installed but not working.

7. LEAD AND PLASTIC COVERED WIRE

7.1 Lead coated power wire per KS-5482-01 may be called for as the result of local code requirements. Either lead or plastic coated wire may be provided when additional conductor protection is desirable such as when leads are pulled in tile duct.

8. WIRE PROTECTION - PERMANENT

8.01 Where possible dress all leads to clear sharp corners or projections and fasten to secure permanency of the clearance.

8.02 For general protection with fiber apply a minimum thickness of 1/32" e.g., two thicknesses of RM-591862 1/64" fiber. Pieces may be cut from RM-591862 sheet fiber and formed by bending. Secure by the weight of adjoining details or tie with two strands of sewing twine at each end. If neither method is practical secure the fiber with an adhesive. When used, the fiber is generally applied to the framework parts rather than to the power wires.

8.03 Rubber and plastic covered power conductors that do not have an outer fabric covering require added protection from sewing twine used for banding or fastening. See Section 6C.

8.04 Protect all power wire at points where the wire bends sharply across sharp edges of supports such as cable rack straps, stringers or other framework projections which may injure the leads. Prevent injury to power wire by observing minimum bending radii listed in Section 6B.

8.041 P-68616 preformed channel fiber is used to protect power wire bending over cable rack cross straps. P-32B952 Insulator (preformed channel) is used to protect power wire bending over bar type cable rack stringers. This insulator may also be used over sharp edges where power wires turn in the base of duct type bays such as those used in N and ON carrier.

8.05 All wire and cable run supports, where the total pile-up clearance is 8 inches or more, shall have protection at all horizontal cabling surfaces turning downward (except prefabricated 90° turn down assemblies) and at offsets (not in the same horizontal plane) where the radius of the turn or offset at the point of contact with the pile-up, is 5 inches or less.

8.06 Inverted ladder-type cable rack in a horizontal or vertical run shall have the flange side of the cross straps provided with protection. An exception is made when a permanent obstruction limits the ultimate cabling depth to less than 4 inches. Use P-68616 or two thicknesses of RM-591862.

8.07 Wire and cable, turning off bar-type cable racks should be protected by U-shaped fiber insulator P-40B642. These insulators should be placed over the cable rack stringer between the horns at points where wires turn off the rack, except over cable rack stringer clamps. No fastening required.

8.071 Insulators are not required over the tops of power cable brackets having an insulating finish (recognized as a baked porcelainized finish), nor over stringers of frame aisle cable racks that pass under cable runs turning into cross aisle racks that are raised 2 inches.

8.08 Wires and cables resting on the edge (not corners) of auxiliary framing bars or channels or cable rack stringers, and wires offset less than 3 inches over the edge of cable rack stringers or straps do not require protection except as covered in Paragraph 8.06.

8.09 Provide protection where power wire passes through or touches sharp edges of sheet metal openings.

8.091 Any place where flanged wire duct is in use such as TD-2 stations, power wires shall be protected when passing within 1/2" of the outside of wire duct flanges. Where protection is needed, use split fiber tubes on the duct flanges as follows:

Piece Part No.	Duct Trade Size
P-41E562	2-1/2"
P-41E563	4"
P-41E564	6"

8.10 When previously installed wire protection has been dislodged it shall be put back and made secure before performing subsequent wiring and cabling operations.

8.11 Power wires fastened to the underside of channel type cable rack straps shall be protected by first placing two layers of RM-591862 sheet fiber or lengths of P-68616 channel fiber protector over the flanges.

9. CODE REQUIREMENTS

9.1 The power plant installation shall meet any special requirements of local authorities, and the wiring (service leads) and equipment connected directly to the outside power service and the emergency alternator set shall also meet the requirements of the National Electrical Code.

9.2 To meet National Electrical Code requirements it is not ordinarily necessary for the installer to refer to the code on work covered by instructions. Reference should be made to the code on work not covered by instructions when equipment or wiring connected to the outside power service or to the emergency alternator set is involved.

9.3 Before or upon completion of the power work, the Western Electric Company shall ascertain from the telephone company whether inspection by the city or Underwriters is desired of the emergency

alternator set, and of the wiring and equipment connected directly to the outside power service; if so, after completion of the power work, such inspection shall be requested by the telephone company or, at their direction, by the installer. Any certificates or approval received by the

installer shall be turned over to the telephone company. This does not include wiring, machines, batteries, etc., to which the telephone circuits are connected since they are classed as signaling equipment under the code and do not require approval of inspectors.

➤ Arrowed lines indicate new or changed information.

[Vertical lines at side of paragraphs indicates requirements.

Manager, Product Engineering

Reason for Reissue:

- (1) To specify R-3055 All Plastic Safety Goggles under Tools table. (Par. 3.11)
- (2) To add additional information to Par. 2.41 "Against Personal Injury".
- (3) To update Fig. 1.
- (4) To change No. 12 twine or nylon twine to sewing twine. (Par. 8.02)

Replaces Section 6A dated 1-16-64.