A. General

This instruction lists the standard formats to be used in designating various types of cable assemblies on all Company documents and records

Standard abbreviations:

Description	Abbreviation	Description	Abbreviation
Conductor Size	kcmil (Formerly MCM)	Varnish Cambric	VC
		Rubber	R
Conductor Size	AWG (American Wire Gauge)	Polyethylene	P
		Cross–Linked Poly	X
Paper–Insulated–lead Covered	PILC	Series Light	SL
Concentric Neutral	CN	Multiple Light	ML
Bare Neutral	BN	Lead	L
Network Type Cable	NW	Kilovolts	kV
Aluminum	AL	Tape Shield	TS
Longitudinally – Corrugated	LC	Protected (Jacketed)	P
Aerial	A	Conductive Jacket	PC
Flat Strap	FS	Duct	D
Reduced Insulation Wall	RW	Cable in Conduit	C/D

General Rules:

a. When copper conductors are used in a cable assembly, the conductor material is not specified in the cable description. If the conductor material is aluminum, AL is used.

b. When the cable is of the paper–insulated lead–covered type, the insulating material and the lead sheath are not specified.

c. When the letter ”P” if used following PILC cable descriptions, it indicates a protective covering has been installed over the metal cable sheath. When the letter ”P” follows a comma, as CNX, P, the ”P” stands for a jacket over the shield or concentric.

d. AWG conductor sizes below 1/0 should use the numeral sign (#) preceeding the AWG wire size (Example #2).

B. Paper–Insulated Lead–Covered Cable (PILC)

All PILC cable designations follow one of the forms listed below. The conductor size is specified in kcmil or AWG, followed by the number of conductors under a common covering. The letter P is added if the sheath is jacketed and then the voltage is stated in kV.

Cable Description	Handwritten	Typed
800–3C, 35kV, PILC	800–^{3}35 kV	800–3C, 35kV
4/0–3C, 15kV, PILC Jacketed	4/0–^{3}P,15 kV	4/0–3C, P, 15kV
750–1C, 35kV, PILC	750–^{1}35kV	750–1C, 35kV
Three 750–1C Jacketed Cables installed in the same duct	3–750 P, 35kV	3–750 P, 35kV

C. Lead−Covered Cables with Insulation Other Than Paper

These cables normally consist of one or three conductors under a lead sheath. The insulation is usually rubber (abbreviated ”R”) or Varnish cambric (abbreviated ”VC”). The lead sheath is identified by the letter ”L”. These letters are added to the form specified in Section ”B” in the position shown in the samples below.

Cable Description	Handwritten	Typed
Rubber−insulated lead−covered 500kcmil 15kV−3 cables triplexed (18−08−207). No longer stocked	3−500 RL, 15 kV	3−500 RL, 15kV
Varnish Cambric insulated lead−covered, 500 kcmil, 1C, 1000 Volt (18−08−019). No longer stocked	500−^{1}VCL, 1kV	500−1C, VCL, 1kV
Rubber Lead − 300 kcmil, 3C, 600 V (18−08−014). No longer stocked	300−^{3} RL	300−3C, RL

D. Multi−Conductor Assemblies of Single Conductor Cables (Other than Concentric Neutral Type)

This cable is identified by stating the number and size of all conductors. When the neutral is the same size as the phase conductor, it is included with the phase conductors. If the neutral is bare, the abbreviation ”BN” is added to the description following the conductor size. If the neutral is smaller than the phase conductors, it is specified following the phase conductor by adding the multiplication symbol ”x” and the size. If more than one conductor is used for the neutral, the number of conductors must be specified.

Example: 3−500 kcmil phase conductors with a 4/0 bare neutral − 3−500 x 4/0 BN
3−750 kcmil phase conductors with 3−#2 covered neutrals − 3−750 x 3−#2

To complete the description, the conductor metal must be shown if it is other than copper. Also, the insulation material and the rated voltage must be shown. If the rated voltage is 1000 volts or higher, the voltage is specified in kV (Example: 5kV). If the cable is rated at 600 volts, the voltage should not be shown. Any other cable assemblies designed for underground use, but not rated 600 volts should carry the rated voltage in volts (Example: 300V).

Several complete examples are given below.

Cable Description	Written or Typed
Pole Riser − Rubber Insulated 5kV consisting of 3−750 kcmil phase conductors and 3−#2 or 1−4/0 neutral conductors (18 07 031).	3−750 x 3−#2, R, 5kV 3−750 x 1−4/0, R, 5kV
URD Secondary − Cross−linked polyethylene insulated consisting of 2−350 kcmil aluminum phase conductors and a 3/0 AWG aluminum insulated cable triplexed together. Rated voltage 600 volts (18 07 201).	2−350 x 3/0 AL, X
URD Service − Cross−linked polyethylene insulated consisting of 2−3/0 AWG phase conductors and 1−1/0 AWG neutral conductor twisted together. All conductors are aluminum. Rated voltage is 600 volts. 18 07 202, or	2−3/0 x 1/0 AL, X
2−350 kcmil with a 3/0 neutral in duct (18 07 248).	2−350 x 3/0 AL, X, C/D

E. Network Type Cable − Rubber

Network cable (abbreviated NW) is a special construction of the cable specified in Section D. It consists of copper conductors covered with rubber insulation and a tough neoprene rubber jacket. It is rated 600 volts. This cable is identified by placing the abbreviation ”NW” as a suffix to the description stated in Section D, Paragraph 1.

Cable Description	Written or Typed
Network – 500 kcmil, 3C x 4/0 AWG	3–500 x 4/0 BN, NW
Bare Neutral – 600 V. (18 07 010)	
Network – #2 AWG, 3C, 600 Volt	3–#2 BN, NW
Bare Neutral (18 07 026)	

F. Network Type Cable – Cross–Linked Poly

Another class of cables is crosslinked network. This cable has a copper conductor, is cross–link poly insulated, and is basicly used as a duct cable was therefore designated as a network style cable with the NW description, rated 600 volts. See Ameren Material Spec. 2.2.206.

The usual description for item C which has a bare neutral would be: 3–2/0 NW, X, BN. Item D would be 3–1/0 NW, X because all three conductors are insulated.

Stock No.	Stock Description	Assembly of Insulated	Conductors Bare (AWG)	Record Description
18 07 011	NW, 1–750 kcmil	1–750 kcmil	–	1–750 NW, X
18 07 027	NW, 3–4/0 AWG (BN)	2–4/0 AWG	1–4/0	3–4/0 NW, X, BN
18 07 246	NW, 3–2/0 AWG (BN)	3–2/0 AWG	1–2/0	3–2/0 NW, X, BN
18 07 043	NW, 3–1/0 AWG	3–1/0 AWG	–	3–1/0 NW, X
18 07 026	NW, 3–#2 AWG (BN)	2–#2 AWG	1–#2	3–#2 NW, X, BN
18 07 001	NW, 4–#2 AWG (BN)	3–#2 AWG	1–#2	4–#2 NW, X, BN

G. Primary–Extruded Insulation Concentric,Tape, Longitudinal Corrugated, or Flat Strap Shield

To identify this type of cable, the number of insulated conductors making up the cable the size of the conductor, the conductor metal, the abbreviation ”CN” indicating concentric neutral followed by the abbreviation for the style of insulation and construction. A comma and the rated voltage follow.

There are several types of extruded ”High Voltage” cable insulations on the Ameren System. All types of rubber cable insulations use ”R” to designate the rubber regardless of the style of rubber cable. X is used to designate cross–linked poly while P was used when Ameren purchased high molecular weight polyethylene which was not cross linked. While manufacturers used HMWP, Ameren used ”P” (Poly) for the insulation description. For concentric neutral cables designated CN the X, P, or R should follow the CN immediately CNX, CNP, CNR. All cable currently purchased for URD primary will also have a P in the abbreviated description to indicate jacketed. Hense ”CNR,P” is the modern URD cable now being used. It is important to cable operations that all cable be accurately posted with its proper abbreviated description and date of installation, month and year.

Cable Description	Posting
1–#2 AL, Rub, 15kV, Concentric Neutral, Jacketed	1–#2 AL, CNR, P (F) M/Yr.
3–#2 AL Rub, 15kV, Concentric, Triplexed, Jacketed	3–#2 AL, CNR, P (F) M/Yr.
3–750 AL, Rub, 15kV, Concentric, Triplexed, Jacketed	3–750 AL, CNR, P (F) M/Yr.
3–750 Rubber, 15kV, Longitudinal Corrugated Shield	3–750, LCR, P(F) M/Yr.
*3–350, Rub, 15kV, Flat Strap, Tripl., Jkt, Reduced Insul.	3–350, FSR, P, RW(F) M/Yr.
*3–750, Rub, 15kV, Flat Strap, Tripl., Jkt, Reduced Insul.	3–750, FSR, P, RW(F) M/Yr.
1–#2 AL, Rub, 15kV, Conc. Neutral, Jacketed in Conduit	1–#2 AL, CNR, P, C/D (F) M/Yr.

1–1000 Rubber, 15kV, Tape Shielded, Jacketed	1–1000, TSR, P(F) M/Yr.
3–350 Rubber, 35kV, Longitudinal Corrugated Shield	3–350, LCR, P (H) M/Yr.
3–750 Rubber, 35kV Flat Strap Shielded Jacketed	3–750, FSR, P (H) M/Yr.

* Used by Heavy Underground Only.

H. Identification of Rated Voltage on Plat Book Records

In identifying rated voltage of cables on the plat book records, the following letters are used and the voltage used in the description above is eliminated.

A – 600 Volts or Less	D – 8.0 kV	G – 27 kV
B – 500 Volts d.c.	E – 6.6 kV	H – 35 kV
C – 5 kV	F – 15kV	J – 69 kV

In actual practice, the letters B, D, E, and G are no longer used.

When a cable is rated at a higher voltage than its operating voltage, it should carry the symbol corresponding to its rated voltage on all plat book records. The circuit name will show the operating voltage of the cable.

Guide for the use of insulating compounds (I semi fluid, II fluid, III resin based).

STOCK DESCRIPTION:

I. Compound – Insulating – – –

A. –Asphaltic – Semi–Fluid, Low Loss Stk. No. 31 53 074 (new) T&D Spec. 2.2.88

TEMP.
Min. Pour 280 Flash Pt. 430.
Max. Pour 400°F

FOR USE IN

1. All PILC potheads rated through 35kV

B. Petroleum Base – Petrolatum Stock No. 31 51 062

TEMP.
Min. Pour 250°F Flash Pt. 400°F
Max. Pour 350°F

FOR USE IN

1. All PILC joints rated through 35kV where factory paper insulation is used.
   Exception: a. 35kV crotch joints Use Stk. No. 31 51 020
2. All paper lead transition splices where hand applied tapes are of the varnish cloth type (varnished polyester)

II. Compound Insulating–Fluids

A. – 219 – Oil Fluid – A. Stk. No. 31 51 003 (042) T&D Spec. 2.2.135 (55 Gallon Drum)◀—

TEMP.
Pour 70/105°F Flash Pt. 445°F

1. All cable terminal chambers on the network system.
2. All hot test caps through 35kV. (31 51 003)

B. Polybutene – Fluid B

Compound Insulating, for poly and rubber joints and transition splices, where lead sleeves are used.

U.E. Stock No. 31 51 049 (Usually G&W Novoid 224)

III. Resin Base – Oil Insoluble Stk. No. 31 53 028

1. For use in special applications where migration could be a problem.

TEMP.
Minimum Pour 300°F Flash Point 450°F
Maximum Pour 375°F

IV. Gel – Cold Mix – Stk. No. 31 51 099 ◀—

1. For use in PILC Joints and Potheads.

SCOPE

This instruction covers the handling and use of Varnished polyester (glass) insulating tapes used in the hand insulating of paper lead cable.

STORAGE OF MATERIALS

The tapes shall be stored in closed polyethylene bags or sealed cans. Unstored bags left in the air shall not be used. Materials left unused in trucks or other equipment stored in poly bags shall not be used if the storage period exceeds 3 months.

Peeling

The mastic used to secure the end of the roll shall be cut off.

Heating

The peeled tapes shall be placed in the aluminum taping pot with sufficient 219 oil to cover the tapes. The pot and oil shall be heated to 150^{o}F prior to taping. (Compound insulating 219 – Stock No. 31 51 003 in gallon cans.)

Taping

1. Start the tape application in the lowest spot usually next to the connector.
2. Fill in lower spot first, fill in level pulling the tapes tight to obtain a void free fill.
3. Care shall be taken that no sharp step is created that causes voids.
4. Pour or wipe oil over each half lapped layer as the tape is applied.
5. Each new pot of tapes shall be heated. No tapes shall be applied cold.

TEST each leg for firmness before going on or applying the shield.

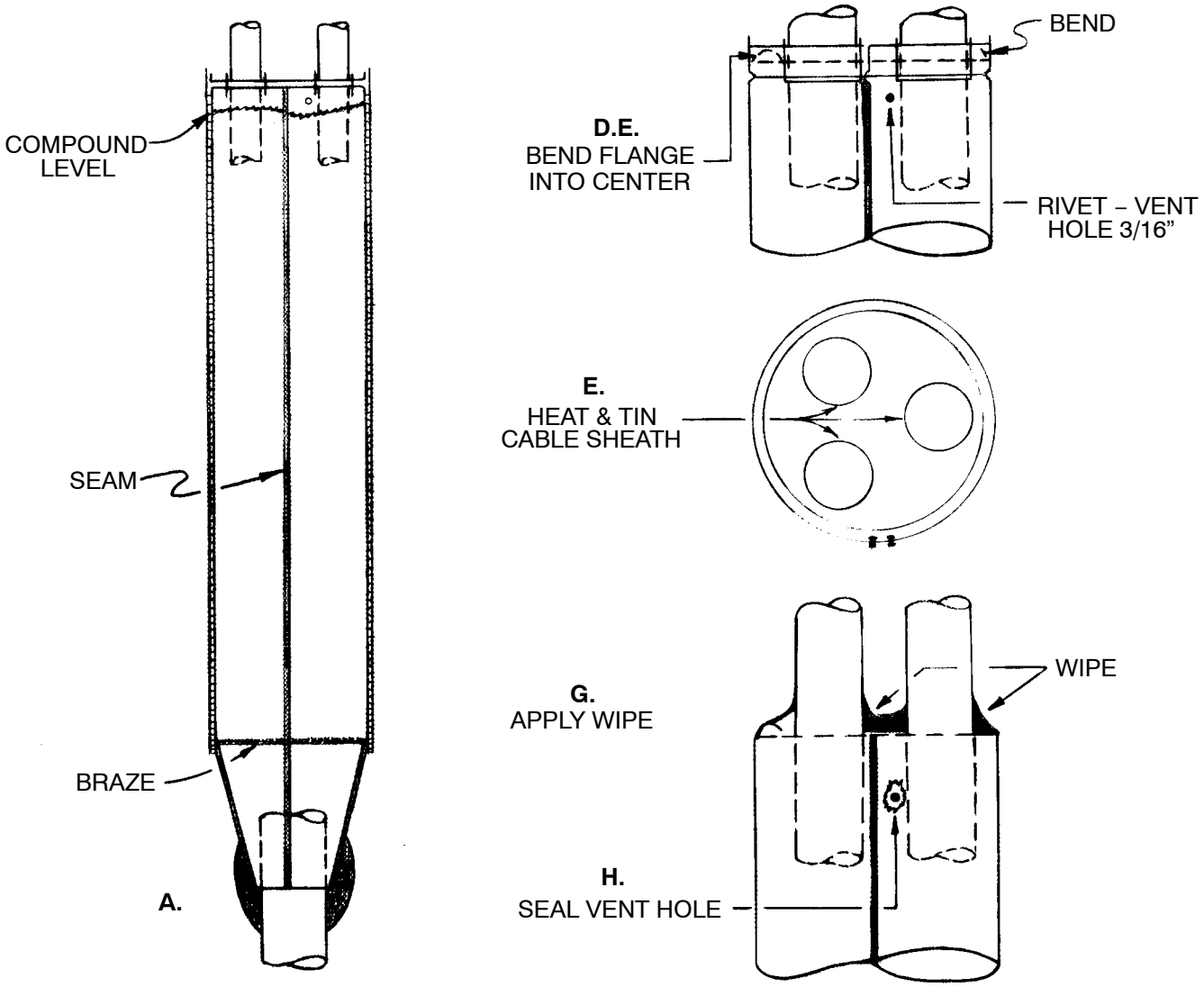
SEALING TRIFURCATING SLEEVES

A. The sleeve should be placed with the seam away from the pole or support structure.

B. Apply the bottom wipe tinning the copper sleeve and sealing the cable to lead sheath.

C. Fill the joint with compound leaving 1–3/4 to 2 inches of depth unfilled so that the compound does not run out of the brass riveted venting hole.

D. Place the trifurcating end cover into the copper sleeve dished up until it sits tightly onto the rolled indent.



E. Peen the ”1” inch of copper sleeve above the indent so that it leans into the trifurcating end plate. See figure.

F. Heat and tin the sheath of the single conductor cable where they will contact the wipe before placing the mass of lead which makes up the wipe.

G. Apply the wiping solder while in the plastic state wiping and securing a tinned connection between the solder, sheath, and copper sleeve.

H. As the last step, solder seal the brass rivet hole to the copper sleeve.

CONNECTOR TINNING

1. The conductors shall have been previously prepared by proper cutting with a hacksaw and stripped to the dimensions indicated per standard.
2. The insulation shall be protected by wrapping with several layers of glass taps 25 53 057 at the shoulder to prevent scorching during tinning.
3. The conductors must be well coated with paste flux, 22 02 255.
4. The connectors must be squeezed onto the conductors tightly but allowing the proper 1/8 inch slot opening to allow for proper tinning of the conductors.
5. The solder shall be tinning hot, 370ºC (a cardboard or heavy paper quickly dipped into the solder shall turn brown but not burst into flames).
6. Starting at one end pour hot solder into the slot until the solder has heated the copper to the extent that molten solder runs through the connector. Then move the pouring back and forth along the slot.
7. Continue to pour solder into the slot using the cooling solder in the catch box. Pour and force mushy solder into slot until a solidly filled connector is obtained.
8. Use the gloved finger or wiping cloth to smooth the soft solder across and around the connectors.
9. After cooling, file and sand the connector to obtain a smooth finish removing any burrs or lead piles created during the tinning.
10. Remove the glass tape and dress up the shoulders of the insulation. Remove any burns or damaged insulation, and assure that no lead burrs remain.

I. General

The following instructions apply to all 35 kV joints shown in the **41 40 ** **** sections of the Dist. Const. Standards.

II. Precautions

1. Great care must be exercised to prevent moisture, dirt, or metal particles from getting into the insulation or the cable compound during construction of the cable joint.
2. During warm weather or in warm manholes the splicer shall keep his hands clean and free of perspiration by wiping them with rags and solvent degreaser while doing any work on the insulation.
3. All materials in direct contact with the insulation such as spacer blocks and wood chisels shall be boiled in oil until free of moisture and kept in oil until used.
4. All boiling out operations to be made with GE 219 taping oil (31–51–003) heated to 135° – 140° C during summer and 140° – 145° C in winter.
5. During the process of making the joint, the cable must not be bent or the conductors spread to such a degree that the insulation is damaged.

III. Preparation of the Manhole

1. A guard shall be placed around the manhole opening when necessary to prevent street dirt from blowing into the manhole.
2. Wipe all moisture and loose dirt from the roof, side wall, the cable to be worked on and other cables adjacent to the point where the joint is to be made.
3. In damp or wet manholes place a rubber blanket above the working area so that moisture cannot drop into the joint.

IV. Training

1. Train the cables into approximately their final position and support them on wood blocks and/or rollers on the iron pin cable supports.
2. Cables shall be trained so that a 6 inch section of straight cable extends from the duct mouth before beginning a bend.

V. Determining the Center of the Joint

1. Select a point, along the overlapping cable ends, for the center of the joint, so that there will be at least 21 inches of straight cable on each side of this center.
2. Wrap a marker tape around the cables just back of the center and cut the cables at right angles to their axes at this point.

VI. Removing the Lead Sheath and Belt or Binder Tape

1. General
   a) Mark the lead sheath at the point where it is to be removed.
   b) At this point cut a groove around the cables halfway through the lead with the chipping knife.
   c) Clean with a wire brush or sand cloth and inspect the lead sheath for a distance of 4 inches back from the groove.

d) Make a longitudinal cut in the section of lead between the groove and the end of the cable.

e) Remove the lead sheath by tearing it off at the groove around the cable. This will leave a partial belling of the lead sheath.

2. Belted Cable

a) Complete the belling of the lead sheath with a fibre belling tool, using care to avoid damaging the insulation.

b) Tie a string around the belt insulation at a point 1 inch from the lead sheath.

b) Remove the belt insulation by tearing against the binder string.

c) Wrap 4 layers of V.P. tape over belt and tie off tightly.

3. Shielded Cable

a) Unwind any binder tape and cut off as close as possible to the lead sheath.

b) Bind the cable next to lead sheath with 4 layers of 1 inch V.P. tape.

VII. Preparing the Outer Sleeves

1. General

a) Copper Sleeve
Carefully clean the sleeve.

b) Lead Sleeve
Carefully clean the sleeve, wire brush and inspect the outside of the sleeve for a distance of 4 inches from each end.

2. For Oil–Filled Joints

a) Insert brass bushings (for fitting) and solder them in place being careful not to get solder on the inside of the bushing (19–11–094).

b) Remove any solder from the inside of the sleeve.

c) Slip the lead sleeve back over the cleaned cable.

3. For Compound–Filled Joints

a) Same as for VII–2 except at one end of the sleeve the bushing is to be soldered in place after filling the joint. This half is to be on the cable at the lower or filling end.

VIII. Preparing the Conductor Ends and Shaping Conductors

1. Remove the fillers to within 1/2 inch from the belt on belted cable or the lead on shielded cable.

2. On shielded cables, unwind the copper shielding tape on the conductors, overlap and tack solder. 4 inches from the sheath. Place spacer blocks.

3. Wrap plastic sheeting tightly around the three conductors from the lead to the spacer blocks.

4. Shape the conductors straight and parallel to the cable.

IX. Stepping Conductor Insulation

1. Tie a string around the conductor insulation at the furthest step.

2. Remove ten layers of paper, tearing each layer against the string leaving a rough tapered surface.
3. In succession at each step tie a string and remove ten layers. At the last step remove half of the layers, and with the last string tied remove the remaining layers.
4. Wrap the insulation with plastic sheeting before working on the other conductors.

X. Installing Copper Connectors

1. Spread the connectors uniformily, sufficient to allow them to be slipped over the conductors.
2. Apply soldering paste to the conductors and slip all the connectors on the cable by grasping the cable with both hands, one just back of either crotch and push the two cable ends out toward the wall of the manhole until the ends of the connectors just pass the other conductor ends. Adjust each conductor to fit into the copper sleeve. Pull the cables back in the same manner.
3. Press the copper connectors together shaping them to conform to the conductor leaving no open space between the conductor and the inside of the connectors. Tap down any sharp edges with a ballpeen hammer.

XI. Soldering Copper Connectors

1. Carefully protect the end of the insulation and part of the exposed copper with several layers of glass tape, leaving 1/8" exposed copper next to sleeve.
2. Apply more soldering paste and then pour hot 50–50% solder into the slot in the connector until the conductors are properly tinned.
3. Allow the solder to cool until a surplus of solder can be built up over the ends and along the slot in the connector, making as smooth a wipe as possible.
4. With a sharp knife cut off any rough spots and projections of solder and sand connector.
5. If the solder is not smooth or other imperfections are noted, resolder and repeat the operation.
6. Remove the glass tape.

XII. Preparation of V.P. Tape

1. Open the can of V.P. tape and pour out oil into stewing pan.
2. Heat oil to 135° C.
3. Remove a 2 foot sample of tape and test for moisture by placing it in the hot oil. If the tape bubbles the entire can of tape shall be tagged and returned to the Stores Department as wet tape.
4. Pour hot oil back into can over V.P. tape.

XIII. Applying the Tape

1. General
   a) Remove the spacer blocks and remove plastic only from conductor to be worked on, also cut the strings holding the stepped paper insulation. On Anaconda's cable remove the semi–conducting (carbon black) tape to a point 4 inches from the lead sheath.
   b) Boil out the conductor to be worked on, when conditions are very wet and legs may get wet.

c) Pour cold #219 taping oil from a new can over the conductor.

d) Remove the V.P. tape from the can and remove the strings or stickers. Place sufficient rolls of tape into stew pan filled with oil.

e) With the V.P. tape folded lengthwise fill the gap between the connector and the first step, gradually building up evenly over the connector.

f) Tape back and forth between steps until even with the conductor insulation.

g) Continue taping between the limits of 4 inches from the lead sheath. Each successive layer to be stopped about 1/2 inch from the underlying layer thereby forming a long taper. The center portion of the taping should be built up to the required circumference.

h) The V.P. tape should be drawn tight after each turn or tightened after not more than 4 turns by gripping the last turn and twisting it with the lay.

i) Use the warm taping oil freely on <u>every</u> layer.

2. <u>For Joining Shielded Cables</u>

a) At one end solder the shielding braid to the copper shielding tape.

b) Butt wrap the shielding braid, covering the insulation across the entire joint and solder to the copper shielding tape on the opposite end of the joint.

c) Solder the shielding braid across the entire joint with a soldering iron, touching the copper tape and braid lightly to prevent injury to the insulation or the expelling of any compound from under the tape.

3. <u>For Joining Shielded and Belted Cable</u>

a) Build up the insulation at the crotch of the shielded cable after the conductors have been taped as in XIII–1. The taping must be in a cone shape starting in the crotch at the edge of the tack soldered factory shield and extending for 4 inches.

b) Wrap the shielding braid around the built–up cone, stopping at the highest point.

c) Solder the braid to prevent it from unraveling, tack soldering to the factory shield.

4. For Joining Three Conductor Shielding Cables
<u>With Three Single Conductor Cables</u>

a) Apply the copper shielding braid over the entire length of each conductor and solder in place as in XIII 2C, and solder to the copper band on the single conductor side.

b) Solder the copper band to the single conductor lead sheath.

XIV. <u>Wrapping the Binder Belt</u>

1. Wrap V.P. tape over all three conductors, covering the center of the joint with three layers of tape.
2. Boil out the complete joint with taping oil heated to 120^{o}C.

XV. <u>Wiping Outer Sleeve</u>

1. Slip the sleeves in place and wipe the two halves together.
2. Center the sleeve.
3. Insert the lead wedges around the cable at each end of the sleeve and tap them in place.

4. Place markers around the cable sheath at each end at a distance of 1 1/2 inches from the sleeve.
5. Remove the fittings or plugs from the sleeve to permit the escape of air during the wiping operation.
6. Wipe the sleeve to the cable sheath. Do not use stearine to cool wipes.

XVI. Filling of the Joint

1. Type of Filling Compound
   a) For completely shielded joints, connecting shielded to shielded cable, fill joint with (Molex) oil insoluble compound 31 53 028 (or Petrolatum 31 51 062).
   b) For all joints connecting to submarine cables, fill with GE 5314 oil 31 51 020.
   c) For belted cables where no reservoirs are available and on new cable where temporary joints are to be made, fill with GE 219 compound, 31 51 003 (or Petrolatum 31 51 062).
2. Heating of Compound
   a) Heat four gallons of oil, petrolatum, or compound to a minimum temperature of 145°C in winter and 135°C in summer.
3. Oil (or Petrolatum) Filled Joints
   a) Place a funnel in the hole at the low end of the joint. Pour the oil through the joint until bubbles have ceased flowing out at the high end.
   b) Insert the alemite fitting at one end and a plug at the other end.
   c) For reservoir connection remove alemite and insert Lunkenheimer ”L” and connect flushed tubing.
4. Compound Filled Joints
   a) Place a funnel in the hole at the low end of the joint. Fill the joint with compound.
   b) Fill the joint with the approved filling compound. Fill with hot compound and seal, do not allow to cool and top off.
   c) Replace the bushing and plug and solder the entire assembly in place.