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1. General

This section outlines standard ratings of lightning protective equipment, methods of installation, equipment to be grounded, and methods of grounding.

2. Lightning Protection

Two types of lightning protective equipment are used to protect OH lines and associated equipment. These are Overhead Static Wire and Lightning Arresters.

2.1 Overhead Static Wire

This is a grounded overhead wire installed above the circuit to be protected to shield it from lightning. It is located at an elevation such that a line passing through the static wire and the outermost conductor below it is at a 30° maximum angle with a vertical line. This continuous overhead static wire is grounded by means of a formed copper wire grounding electrode at each pole.

2.1.1 Installation of Static Wire

The preferred method of lightning protection of overhead sub-transmission circuits is through use of an overhead static wire. The static wire shall be grounded at every pole except manually operated group air break switch poles. The best protection is afforded by low pole ground resistance (less than 15 ohms).

Existing circuits which qualify for improved lightning protection shall be protected in this manner. Additional pole height may be required to add a static wire. A fiberglass pole top extension or a wood bayonet can be used for added height.

2.2 Lightning Arresters

Metal Oxide Varistor (MOV) arresters are normally used for protection of overhead distribution circuits or equipment where conditions warrant (e.g. high ground resistance or retrofitting shielded circuits with a poor history of lightning performance). These arresters (mostly zinc oxide) are solid state and are direct connected from line to ground. MOV arresters are sensitive to temporary system overvoltage such as may occur due to ferroresonance or to single phase switching of ungrounded wye-delta transformer banks. In such instances contact Standards engineering for recommendations. Higher voltage arresters may be required.

There are many silicon carbide internally and externally gaped arresters still on the system. These allow a higher discharge voltage than MOV arresters, reducing the surge protective margin. When these are found during work on a pole they should be replaced with a polymer housed metal oxide (MOV) arrester (especially at riser poles).

2.2.1 Installation of Lightning Arresters

When installed to protect equipment, arresters shall be installed as near as practical to the equipment to be protected. See Table 2 for equipment to be protected.

Arresters are also installed on sub-transmission for general line protection. In this application, arresters should be installed on the top phase of every pole where a 30° shield angle exists. Skipping spans severely reduces the ability of the arresters to protect against direct stroke flashovers. Where lines run through wooded areas or close (within 1-1/2 pole heights) to any type of structure at least as tall as the top phase, induce flashovers may be experienced. If outages are experienced in this circumstance, arresters should be installed on the remaining phases of the circuit(s) at roughly 600' intervals. Where a shield angle greater than 30° exists, arresters should be placed on all three phases of every pole in open territory. Where the line runs through areas shielded by trees or other structures, arresters should be installed on all three phases at roughly 600' intervals.

Distribution underbuild, particularly when built with all three phases on one crossarm, will many times experience flashovers from the ground lead of either static construction or arresters on the sub-transmission circuit(s). If experience indicates this to be the case, arresters should be installed on the B phase (closest to the pole).

In all cases the primary connection lead as well as the ground lead should be as short as possible and free of any sharp bends. **Under no circumstances should "pigtail" coils be made in the arrester connecting leads.**

Installation notes:

1. Connect the arrester ground lead before connecting the arrester to the line.
2. Install wildlife guards on line terminals of all line arresters and cover (stk #69 56 037) over transformer sidewall bracket arrester attachment bolt.
3. Do not reconnect arresters with a blown ground lead disconnector.
4. Arresters removed for any reason shall not be re-installed.

TABLE 1. Standard Lightning Arrester Ratings (See NOTES As Below)				
App	Type Circuit	Rating	*MCOV	Stock Number
OH	2400 V Delta	3 kV	2.55 kV	10-01-133
	4160 Gnd Y/2400 V	3 kV	2.55 kV	10-01-133
	4160 Gnd Y/2400 V Trf. Mnt	3 kV	2.55 kV	10-01-122
	4160 Gnd Y/2400 V Terminal Pole	3 kV	2.55 kV	10-01-133
	4160/2400 V with Isolated Neut	3 kV	2.55 kV	10-01-133
	4160 V without Neutral Extended	6 kV	5.10 kV	10-01-184
	4800 V Delta	6 kV	5.10 kV	10-01-184
	12470 Gnd Y/7200 V	10 kV	8.4 kV	10-01-144
	12470 Gnd Y/7200 V Trf Mnt	10 kV	8.4 kV	10-01-145
	12470 Gnd Y/7200 V Terminal Pole	9 kV	7.65 kV	10-01-129
	12470 Gnd Y/7200 V Terminal Pole	10 kV	8.4 kV	10-01-146(3)
	12470 Delta or 14,400 Un-Grounded, Gapped	15 kV	12.7 kV	10-01-188
	13200 Gnd Y/7620 V	10 kV	8.4 kV	10-01-144
	13800 Gnd Y/7970 V	12 kV	10.2 kV	10-01-008
	13800 V Un-Grounded	15 kV	12.7 kV	10-01-008
	13800 or 14400 Delta	18 kV	15.3 kV	10-01-143
	13800 Gnd Y/7970 V Terminal Pole	10 kV	8.4 kV	10-01-146
	24900 Gnd Y/14400 V (Solidly Grounded)	18 kV	15.3 kV	10-01-143
	34500 Gnd Y/19.9kV (Solidly Grounded (Transformer)	27kV	22kV	10-01-234
	34500 Gnd Y/19920 V (solidly Grounded)	30 kV	24.4 kV	10-01-148 (1)(4)
	34500 Gnd Y/19920 V (solidly Grounded)	30 kV	24.4 kV	10-01-147(2)(4)
	34500 Gnd Y/19920 V Terminal Pole	27 kV	22 kV	10-01-137
	34500 Gnd Y/19920 V Terminal Pole, Gapped	27 kV	22 kV	10-01-199(5)
OH	34500 Gnd Y/19920 V Suspended with Side Post Insulator	30 kV	24.4 kV	10-01-239 (4)
	34500 V Un-grounded Delta /Suspended with Side Post Insulator(13)	36 kV	29 kV	10-01-249(5)
	34500 Gnd Y/19920 V Suspended with DE Insulator	30 kV	24.4 kV	10-01-237
	34500 V Un-grounded Delta /Suspended with DE Insulator (13)	36 kV	29 kV	10-01-248
	34500 Gnd Y/19920 V (Solidly Grounded) -- Intermediate Class	30 kV	24.4 kV	10-01-240(6)
	34500 Gnd Y/19920 V (Solidly Grounded) - -- Intermediate Class	30 kV	24.4 kV	10-01-241(7)
	34500 V Un-grounded Delta - -- Intermediate Class (13)	36 kV	29 kV	10-01-243(9)
	34500 V Un-grounded Delta - -- Intermediate Class (13)	36 kV	29 kV	10-01-242(8)
	69000 V Gnd Y - -- Intermediate Class	60 kV	48 kV	10-01-245(10)
UG	69000 V Gnd Y Suspended with Side Post Insulator	60 kV	48 kV	10-01-158
	69000 V Gnd Y Suspended with DE Insulator	60 kV	48 kV	10-01-236
	12470 V URD	10 kV	8.4 kV	10-01-138
	12470 V URD (Parking Stand Arrester)	10 kV	8.4 kV	10-01-151
	34000 V URD (Small Interface) (11)	27 kV	22 kV	10-01-163
	34000 V URD (Large Interface)(12)	27 kV	22 kV	10-01-177
	34000 V URD (Small Interface)(11)(13)	36 kV	29 kV	10-01-255
SEC	34000 V URD (Large Interface)(12)(13)	36 kV	29 kV	10-01-154
	1 Phase 120 or 120/240 V	175 V		10-01-032

*Maximum Continuous Operating Voltage (MOV)

NOTES:

THIS TABLE DOES NOT APPLY TO ANY ARRESTERS ANYWHERE IN SUBSTATIONS.

- (1) Direct pole mounting
- (2) Crossarm mounting
- (3) Use only when problems are experienced with 9kV (10-01-129) operating frequently or failing due to higher operation voltages (proximity to substation, etc.).
- (4) The suspended arrester is to replace stock #10 01 148 and stock #10 01 147.
- (5) Use on un-grounded delta system.
- (6) Base mount for use on primary metering structure.
- (7) Crossarm mount for use on primary metering structure.
- (8) Base mount for use on un-grounded delta primary metering structure.
- (9) Crossarm mount for use on un-grounded delta primary metering structure.
- (10) Base mount for use on primary metering structure.
- (11) Small Interface is to mount on radial feed.
- (12) Large Interface is to mount on loop feed.
- (13) For un-grounded delta 34kV system.

TABLE 2. Equipment To Be Protected by Lightning Arresters	
Equipment	Arrester Location
Distribution Transformers	Primary Side
Voltage Regulators - Pole Installations	Primary & Secondary Sides
Constant Current Regulators - Pole Installations	Primary & Secondary Sides
Terminal Poles - Lead and Non-Lead Cables	On terminal pole and on same phase on structures each side of riser poles.
Line Switches - Normally Closed	Arresters not required
Line Switches - Normally Open	Install both sets of arresters on adjacent pole for Illinois; for Missouri, install arresters on a separate bracket arm below the switch, and install additional set of arrester on adjacent pole of unprotected side, or install both arresters on adjacent pole if space is limited.
Airbreak Switches - Normally Open - 35 & 69kV	Install both sets of arresters across the dead-end insulators on the switch pole shown DCS 10 34** and 10 69**.
Capacitors	On capacitor rack
Time Switches	On switch
Meters (only on approval of Engineering)	On service entrance equipment
Unshielded Distribution Lines	On crossarm, pole face or primary apparatus. Minimum of 4 arresters per phase per mile (counting apparatus arresters if separated by 600 ft or more).
Deadend Poles (Unshielded Circuits)	Top Phase (Vert): All Phases (Flat)

3. Grounding Practices

3.1 General

Ground rods will continue to be used for grounding pad mounted equipment and existing pole ground installations. For new pole ground installations a formed #2 soft-drawn copper electrode shall be used. This electrode is to be placed at the bottom of the pole and covered with at least six inches of native soil. The vertical lead of the electrode should be trained to the side of the pole hole so that it will not be covered by the crushed rock backfill. If the desired resistance is not obtained additional ground rods can be driven in parallel with the formed electrode but a minimum separation distance of six feet shall be maintained.

3.2 The Common Neutral System

Either a 2400/4160 Y volt or a 7200/12470 Y volt common neutral distribution system is normally used at Ameren. These systems use a continuous metallic conductor which serves as both the primary and secondary neutral conductor. This neutral conductor must be attached to grounds at various points throughout its length to insure adequate grounding of the circuit. These grounds (Table 3) will consist of customers' grounds, lightning arrester grounds, and static wire grounds and occasionally a ground installed solely to provide adequate grounding of the common neutral. Where a common neutral is present, all grounds installed for any purpose shall be bonded to it.

3.3 Number of Grounds – Common Neutral

At least four grounds are required, (counting equipment grounds but not counting customers' grounds), in each mile of common neutral circuit for **both overhead and underground circuits (maximum 1320 feet spacing)**. In cases of random lay underground with other utilities, at least 8 grounds per mile are required. Where it is necessary to install additional grounds because of this requirement, approximately uniform spacing shall be used. See Table 3.

3.4 Size of Ground Wire

The size of ground wire will vary according to the type of equipment being grounded and shall conform to Table 3. In areas of frequent damage/vandalism, 7#10 copperweld should be substituted for the #6 soft drawn copper pole ground wire.

3.5 Multiple Ground Leads on Same Pole

Where both Ameren and communication systems are grounded on a joint use structure, NESC Rule 97G requires that either a single pole ground lead shall be used for both systems or the Ameren and communication ground leads shall be bonded together. This bond should be at the communication worker safety zone (40" below lowest Ameren attachment if made by Communication Company or

at the neutral if connection is made by Ameren.) Where Ameren is maintaining isolation* between primary and secondary neutrals, the communication system ground shall be connected only to the primary neutral ground lead.

The same requirement for bonding of separate ground leads at the neutral level applies for all instances where multiple ground leads are installed (i.e., static/shield wire and system neutral ground leads; Ameren and other electric utility system neutral ground leads).

*See DCS 13 00 06 06, 13 00 06 08, and the delta primary connection diagrams in 13 00 07 02 thru 13 00 07 12 for situations requiring isolation of Ameren primary and secondary neutrals.

3.6 Multiple Ground Rods on Same Pole

Where separate ground rods are used for separate pole grounds, NESC Rule 99C requires a bond wire not smaller than #6 copper or equivalent to be placed between the two ground rods. This bond should be visible at the pole base. All separate ground rods shall be bonded together except where Ameren is maintaining isolation between primary and secondary neutrals.

*See DCS 13 00 06 06, 13 00 06 08. And the delta primary connection diagrams in 13 00 07 02 thru 13 00 07 12 for situations requiring isolation of Ameren primary and secondary neutrals.

3.7 Equipment To Be Grounded (*)

TABLE 3. Equipment To Be Grounded and Size Of Ground Wire			
Case No.	Equipment or Circuit To Be Grounded	Min. Size of Ground Wire	Other Requirements
1	Lightning Arrester	#6	See Note 2 for Sec Lightning Arresters
2	Cable Sheath Grounds	#2	Wipe ground leads to cable sheath at base of potheads and also to standpipe on pole. Inter-connect solidly with arrester ground leads.
3	Concentric Neutral on Terminal Pole	#2	Twist together and route close to arrester and on to the neutral using #2. Tie short #6 SD cu to arrester ground terminal.
4	Capacitors	#6	Hangers are cases to be bonded together and connected solidly to arrester ground lead.
5	Regulator Cases	#6	Connect solidly to arrester ground lead. Keep leads short.
6	Secondary Neutral or Grounded Conductor	7#10 CW	Connect solidly to pole ground.
7	Common Neutral	7#10 CW	A minimum of four grounds per mile, in addition to customers' grounds, is required.
8	Metal Cable Risers	#6	Separate grounds shall be installed for risers carrying non-lead sheath cables.

9	Airbreak Switch	#2	All airbreak switch handles shall be grounded through a separate ground lead and rod. Inter-connection shall be made with arrester ground lead or to the OH static wire.
10	Transformer Cases	#4	All transformer cases shall be grounded. Ground lead from transformer case shall be closely and solidly connected to arrester ground lead.
11	Transformer Windings -pole mounted	#6	See DCS 13 00 06 and 13 00 07 for connection diagrams.
12	Transformer Windings -pad mounted	#2	See DCS Section 50.
13	Metal Lamp Posts & Metal Poles	#6	Metal lamp posts and metal line or guying posts shall be effectively grounded.
14	Reclosers/Sectionalizers	#6	Connect arrester ground lead solidly to equipment tank.
15	S&C Interruption/G&W Wiper Recloser	#2	Connect the recloser bracket to pole ground.
16	Static wire	#2	Connect to pole ground on every pole unless otherwise noted on construction standards.
17	Customer Service	#6	Connect to metallic water pipe system. Otherwise to driven ground rod.
18	Instrument Transformers	#12	Cases of instrument transformers shall be grounded. Grounding of secondary windings shall be per Engineering instructions.
19	Meter Sockets, Troughs & Enclosures	#12	Meter sockets, troughs and enclosure shall be grounded.
20	Long Runs of UG Cable May Require an External Ground Connection	#2	See DCS 41 34 37** for an example of an external ground connection on a splice.

NOTES:

- 1 Pole line hardware (including cluster bracket and streetlight brackets) must not be grounded except with engineering approval.
- 2 Where a lightning arrester is installed on a secondary or service the arrester ground lead shall be solidly connected to any one or combination of the following grounds:
 - a The neutral or grounded service wire.
 - b Customer's common grounding conductor.
 - c Customer's equipment grounding conductor.
 - da. A separate grounding conductor such as a driven rod.

3.8 Ground Wire Attachment and Covering

The ground wire shall be run in a straight line or a smooth curve and shall clear hardware by at least 2 inches. The static ground wire from 34kV circuits shall be routed on the opposite side of the pole away from the closest phase of any underbuilt circuit. Avoid making sharp bends in ground wires. Take care when driving staples onto ground wires to avoid damaging the wire.

Where the ground wire passes over a messenger or guy wire, a loop shall be formed to clear the messenger or guy wire. If necessary a bridge shall be made

from a 6" length of plastic molding, placing the half round of the molding against the pole and taping the ground wire in place in the groove.

Where guarding is not required, grounds shall be protected by being substantially attached closely to the surface of the pole or other structure in areas of exposure to mechanical damage and, where practical, on the portion of the structure having least exposure.

A 4'0" section of molding may be placed over the ground wire in the working area on badly congested poles. The purpose of the molding is to keep linemen's climbers from damaging the ground wire when working on primary circuits.

Ground wire molding is required for installations with no common neutral and separate arrester/equipment tank and secondary neutral grounds. These separate grounds shall be made with 600 volt insulated conductor (use stk #18 53 011) and shall be covered with plastic molding for a distance of 8 feet from the ground. The arrester/tank ground and secondary ground can be connected using an isolation arrester (stk #10 01 019). One ground wire can be connected to a driven ground or coiled ground electrode at the base of the pole but the other ground wire shall be carried (buried) to a driven ground rod at least 20 feet from the base of the pole and connected with #2 SD bare copper conductor.

3.9 Static Wire at Substation

1/0 AAC or 12/7 ACSR static wire shall be electrically continuous and tied into the bulk substation ground grid. Where the connection into the substation cannot be made overhead, direct bury a 4/0 bare copper conductor from the last pole with static termination to the substation ground grid. The 4/0 size conductor allows some safety margin for corrosion. The downlead from the static wire to the 4/0 conductor shall be #2 copper.

3.10 Static Wire Personal Protective Grounds

a Wire Common Neutral

1/0 AAC or 110.8 (12/7) ACSR (or other shield wires having current capacity of 250 amps or greater) may be used for direct connection of protective grounds on 35 and 69 kV circuits if there is a common neutral and #2 copper pole grounds (or other pole grounds with current capacity of at least 50 amps) connected to the shield wire for at least two poles in each direction. The common neutral must also be connected to the down leads at each pole.

b Without Common Neutral

1/0 AAC or 110.8 (12/7) ACSR (or other shield wires having current capacity of 250 amps or greater) may be used for direct connection of protective grounds on 35 and 69 kV circuits with no common neutral present if #2 copper down leads are grounded at every 4th pole (no more than 1200 feet apart); a supplementary grounded rod must be driven at least 6 feet from the closest ground rod. This extra ground rod shall be connected with #2 copper to the #2 copper down lead.

0. Alumoweld Static Wire

Alumoweld static wires have been installed in the past. Do not connect protective grounds to Alumoweld. It may fuse if a fault occurs. To improve protective grounding on 35 kV lines with Alumoweld static and poor ground resistance, #2 copper downleads may be installed at intervals of 4 spans (no more than 1200 feet). Protective grounds can then be connected to the #2 Cu. A supplemental ground is required from #2 copper downlead to a second driven ground.

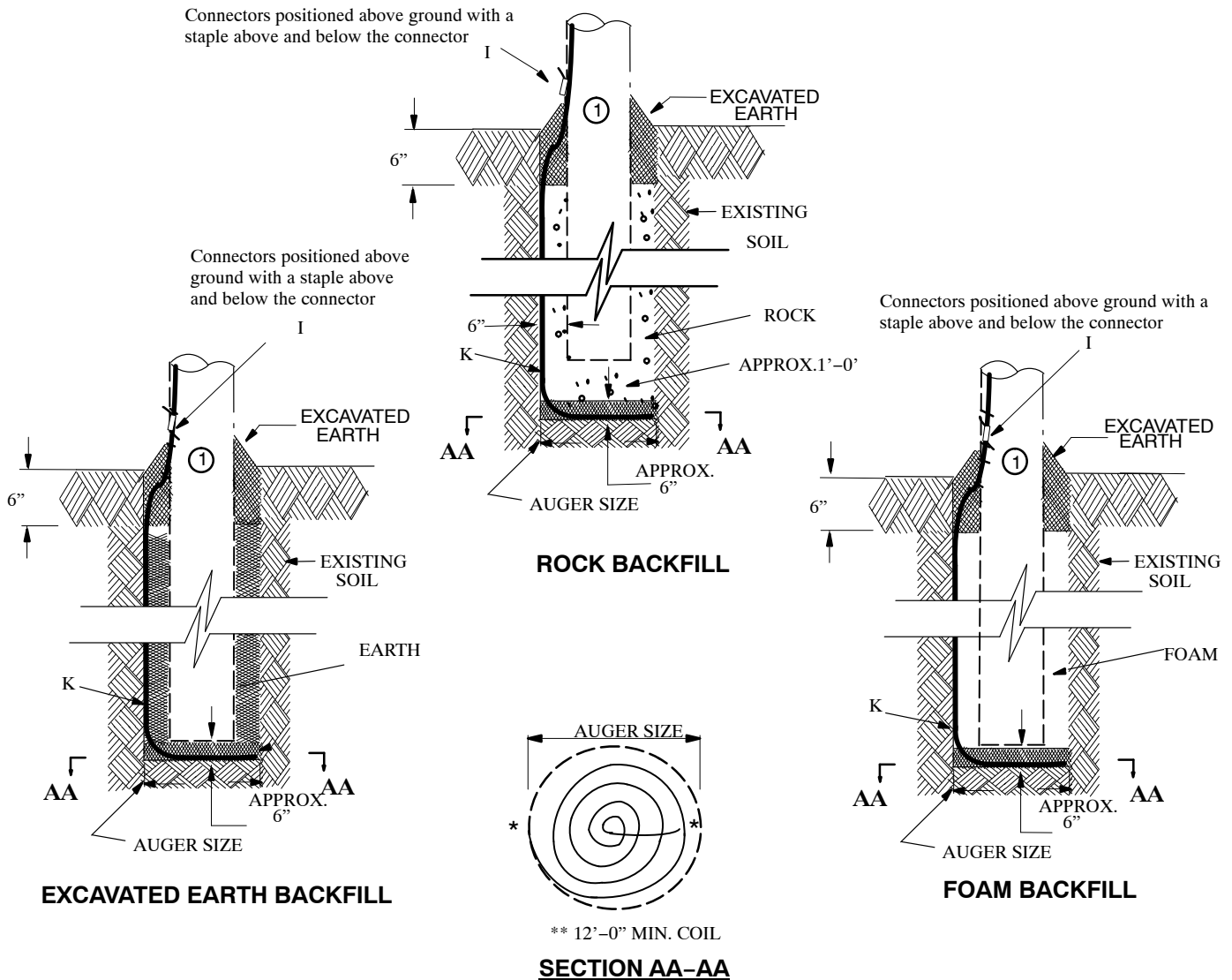
3.12 Static Wire/Common Neutral System

1/0 AAC or 110.8 (12/7) ACSR (or other static wires having current capacity of 250 amps or greater) may be used as the common neutral for lower voltage underbuilt circuits where the run is 3000 feet or more. In such cases the static wire must be continuous and connected to the source transformer neutral with #2 SD poly covered wire.

The static wire shall not be used in place of the secondary neutral. Where secondary is present the secondary neutral shall be paralleled with the static wire neutral and interconnected at every static wire ground down lead. However, where this would result in short discontinuous sections of neutral a continuous neutral shall be installed from the source transformer.

To equalize ground potential static wire ground leads, arrester ground leads, neutral ground leads and equipment case ground leads shall be bonded together with the only exceptions noted in the transformer section of these standards.

BELOW GRADE – NEW CONSTRUCTION



12 00 10 01-7#10 CW Pole Ground/Ground Coil 15kV & Below

12 00 10 04-#2 Cu Pole Ground/Ground Coil 15kV & Below

➔ 12 00 10 09-#2 Cu Pole Ground/Ground Coil 34&69kV

12 00 10 11-Composite Pole 12kV

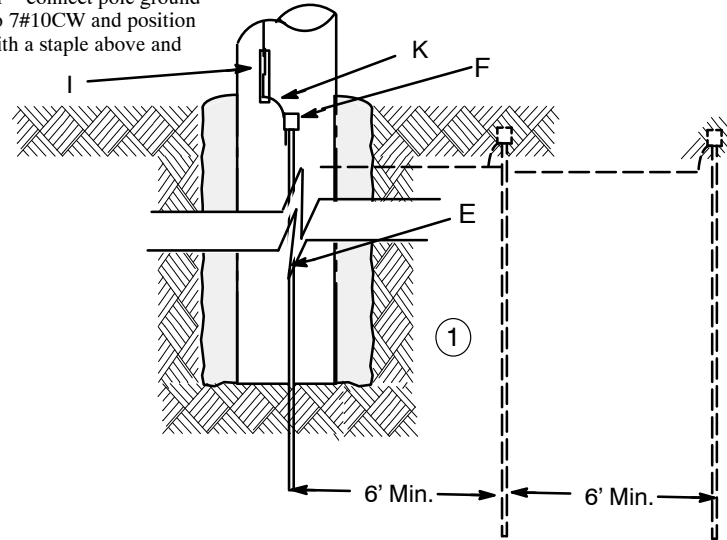
12 00 10 12-Composite Pole 34&69kV

NOTES:

1. Train below grade ground wire approximately 8" above ground line to line up with pole ground wire above grade.
Avoid making sharp bends.
2. See DCS 02 for pole setting depth, reinforcement, and backfill detail.

BELOW GRADE – EXISTING CONSTRUCTION

Non-Tension Sleeve Reducer – connect pole ground wire with #2 solid Cu Bare to 7#10CW and position above ground against pole with a staple above and below the connector



12 00 10 02–7#10 CW Pole Ground/Ground Rod 12kV&Below

➔ 12 00 10 10– #2 Cu Pole Ground/Ground Rod 34&69kV

12 00 10 03–#2 Cu Pole Ground/Ground Rod

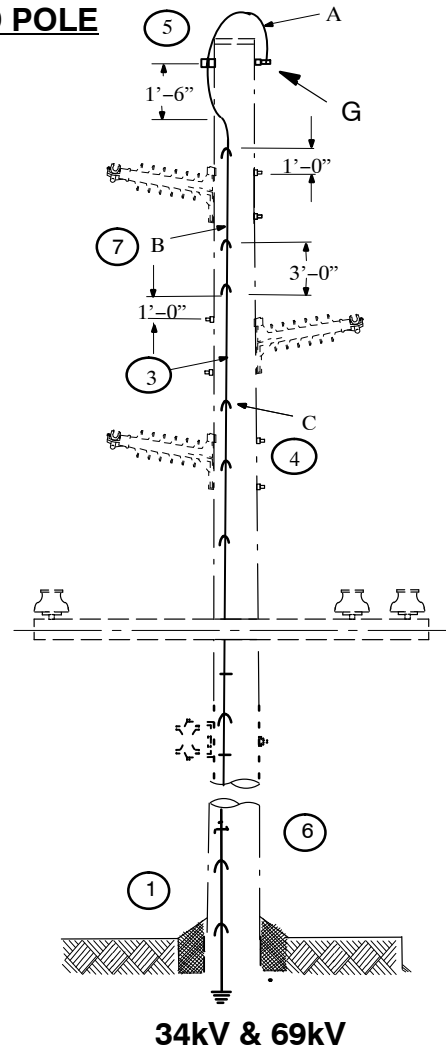
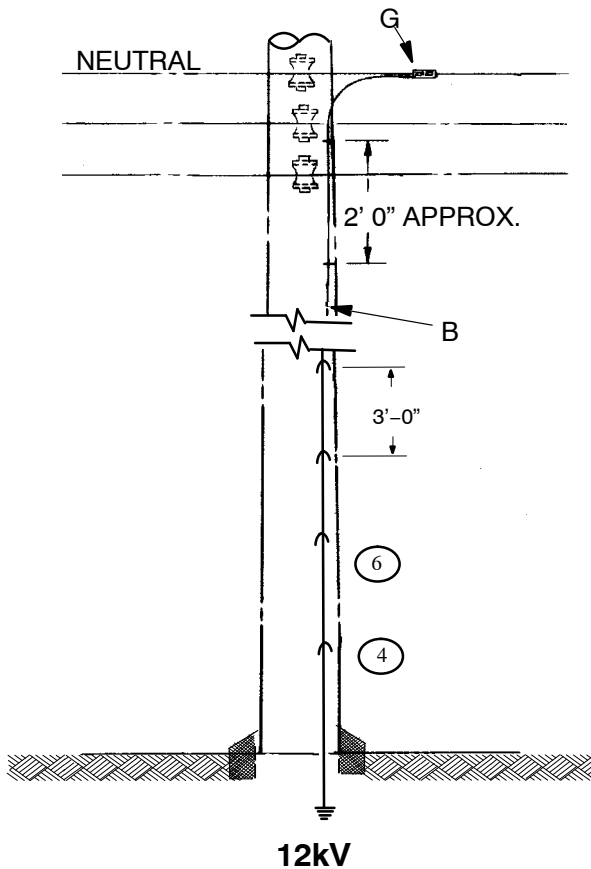
NOTES:

1. Ground resistance will normally be less than 25 ohms with one coil or one rod. In rocky or sandy soil where experience indicates ground resistance may exceed 25 ohms, install additional coil or rods spaced not less than 6' apart. Doubling the number of rods or coils or doubling the length of the rod reduces ground resistance by 40%.

If additional grounding is needed:

- a) terminal poles – a #2 bare Cu counterpoise wire 100'–150' long may be placed in the cable trench and connected to the ground lead.
- b) in rocky soil where driving a rod is difficult – a counterpoise, as stated in a), may be placed in a trench at least 18" deep.

ABOVE GRADE – WOOD POLE



12 00 10 01&04 – New installation

12 00 10 02&03 – Existing Pole Installation

12 00 10 07 – Add Staples

12 00 10 05 – Add Ground Molding/Staples



12 00 10 09–New–2 Cu Pole Ground/Field Formed Coil–34&69kV

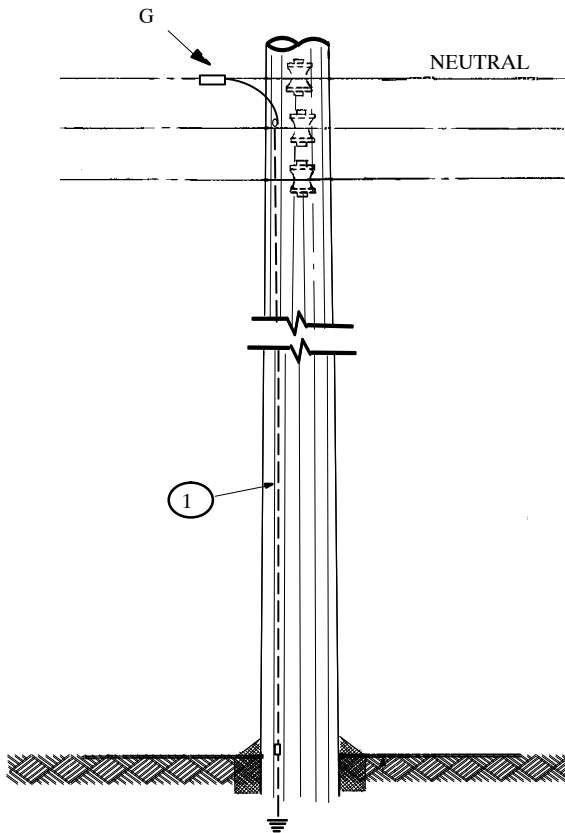
12 00 10 10 –Existing–#2 Cu Pole Ground/Ground Rod 34&69kV

12 00 10 07–Replacement–Add Staples

NOTES:

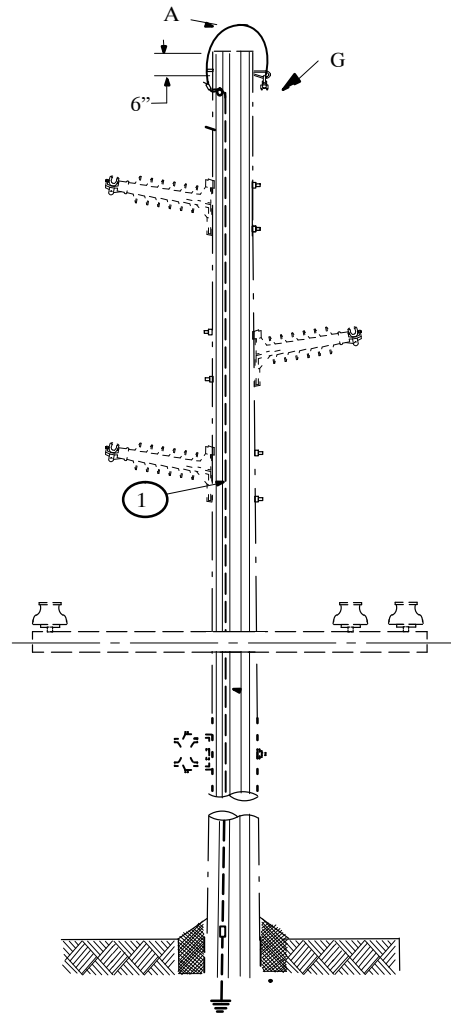
1. The ground wire shall be run in as straight a line down the pole without making sharp bends in such a manner as to clear hardware by at least 2 inches. Avoid damaging ground wire when installing staples.
2. According to an NESC subcommittee's interpretation, metal brackets and straps used to support non-conductive conduits do not need to be grounded. However, conductive material conduits that enclose electrical supply lines or are exposed to contact with open supply conductors must be effectively grounded.
3. Refer to DCS Section 03 for proper grounding position on different structure configuration.
4. Staples are to be spaced 3' on pole ground wire and 1'–6" from top of the pole on 34kV and 69kV line.
5. See DCS 06 00 11 ** for static support assembly and DCS 12 34 01 ** and 12 34 02 ** for lightning arrester connection.
6. Reconnect existing ground wire with 7#10 CW if pole ground wire is missing using DCS 12 00 10 07.
7. Install plastic molding on an existing bare wire pole ground when re-framing an existing pole using DCS 12 00 10 05.

ABOVE GRADE- COMPOSITE POLE



12kV

12 00 10 11-Composite Pole



34kV & 69kV

12 00 10 12-Composite Pole

Notes:

1. Factory installed #2 Cu pole ground.

		Std./Stk. No	Description	12 00 10 **											
				01	02	03	04	05	07	09	10	11	12		
2	A	27 09 215	Wire, 7#10, CW Poly Covered (ft.)	40	40				15						
		18 51 019	Wire, #2 Cu. Poly covered (ft.)			40	40			70	70				
	B	41 56 041	Molding – Grd. Wire, 3/4” x 8’ Long					1							
	C	23 64 001	Staple, Ground Wire, Serrated, Cu Clad	10	10	10	10	10	10	20	20				
	D	23 64 028	Staple, for 3/4” Plastic Molding, Zn Plated Stl					10							
	E	23 13 069	Rod, Ground, 5/8” x 8’ Cu Bond		1	1					1				
	F	17 52 032	Clamp, Grd. Rod, 5/8” for #8 – 1/0		1	1					1				
	G	17 51 032	Clamp, PG. #6 – 1/0	1	1	1	1			1	1	1	1		
	I	17 60 749	Non–Tension Sleeve Reducer, Compression – #2 Cu, Sol to 7#10 CW or #2 Cu, Str.	1	1		1			1	1	1	1		
1 @	K	18 52 025	Wire, #2 Bare Cu, Sol (ft.)	20	2		20			30	2	20	30		
	L	17 60 730	Non–Tension Sleeve, Compression, 7#10 CW						2						
		OP 301	Install Below Grade Ground Coil	1			1			1		1	1		
		OP 302	Install Above Grade Pole Ground	1			1	1	1	1					
		OP 401	Install Pole Ground/Ground Rod		1	1					1				

Note:

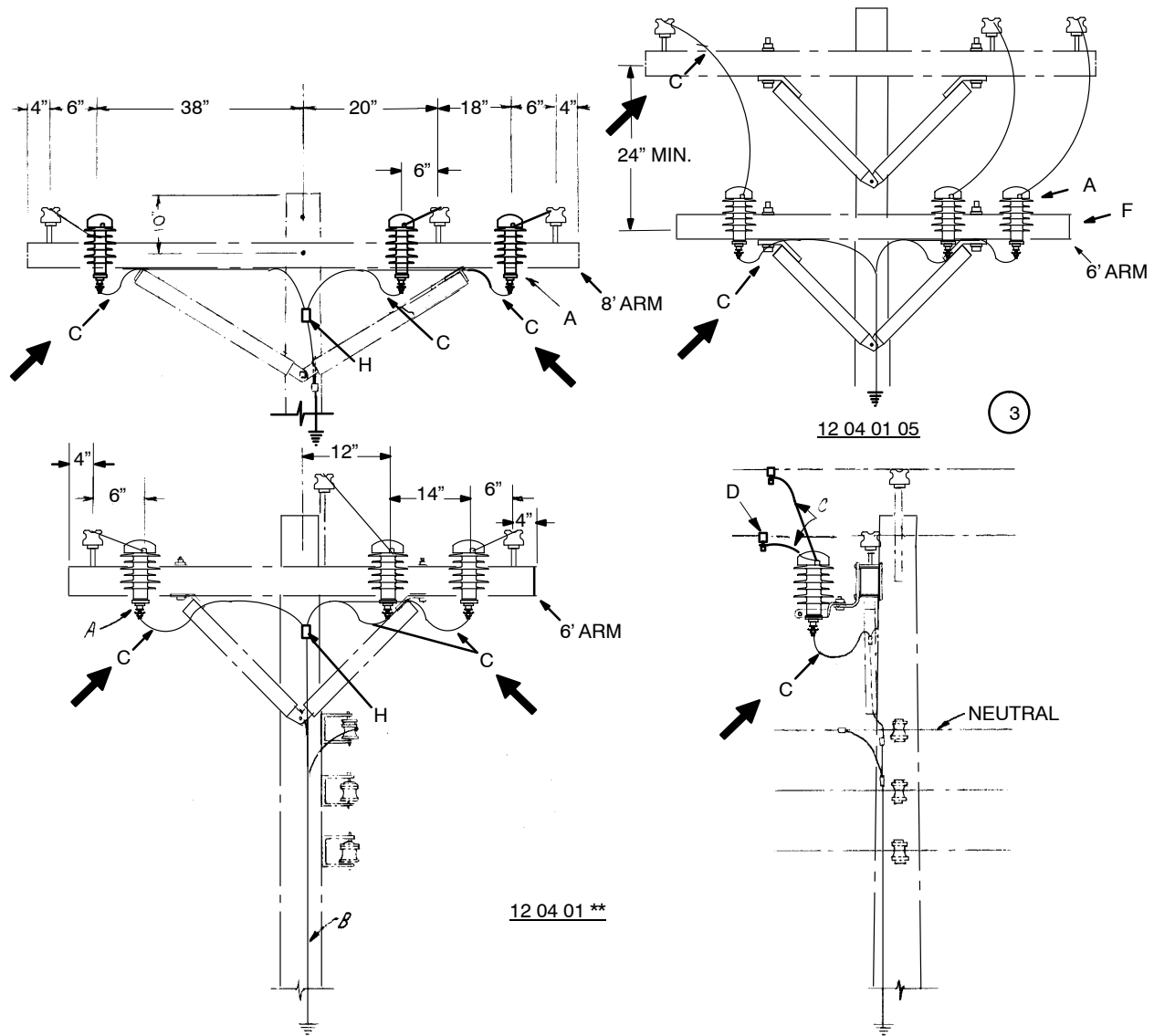
- Use the appropriate connector for the ground wire size being replaced. Non-tension sleeve stock #17 60 730 can be used for 7#10 CW connections, reducing non-tension sleeve stock #17 60 749 can be used for #2 solid Cu to 7#10 CW or #2 stranded Cu connections, and split-bolt stock #17 54 373 can be used for most other connections.
- If a distribution circuit is added to a subtransmission pole with 7 #10 Copperweld or #6 Cu pole ground wire and the static wire is used for the distribution system neutral, the pole ground wire must be changed to #2 Cu or larger.

LIGHTNING PROTECTION AND GROUNDING

Lightning Arrester Installation 4 kV-Existing Circuit

12 04 01 **

Sheet 1 of 2



NOTES

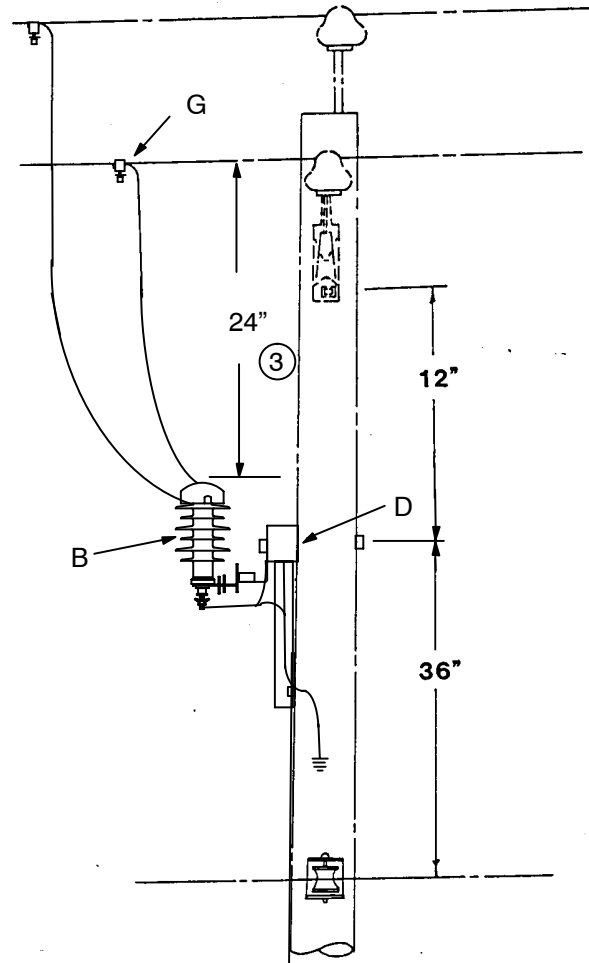
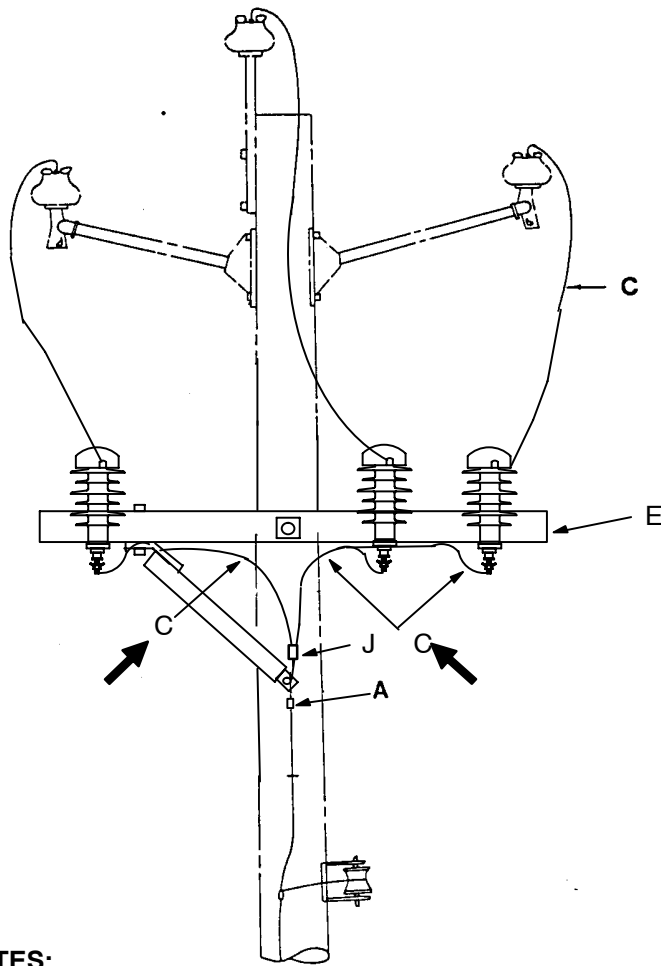
1. Route the ground wires in a straight line or a smooth curve. Avoid making sharp bends in ground wires.
2. Take care when driving the staples onto the ground wires to avoid damaging the wire.
3. If space allows, arresters on separate arm allows installation with 2 man crew instead of 3 in some areas.

		Std. / Stk. No.	Description	12 04 01 **	01	02	03	05
					1-Ph	2-Ph	3-Ph	3-Ph
@	A	10 01 133	Arrester-3 kV		1	2	3	3
@	B	12 00 10 **	Grounding Unit		1	1	1	1
	C	18 51 021	Wire, Cu., #6 S.D., Covered (Ft.)		6	12	17	28
@	D	HLC*W	Clamp, Hot Line		1	2	3	3
	E	17 58 054	Bracket, Crossarm, Arrester		1	2	3	3
	F	04 00 20 01	Crossarm, 6'			1	1	1
	H	17 54 004	Connector, Elect., Split Bolt		1	1	1	1

**DISTRIBUTION
CONSTRUCTION STANDARDS**



ENG:WYW
REV. NO: 8
REV. DATE: 09/08/14



NOTES:

1. Route the ground wires in a straight line or a smooth curve. Avoid making sharp bends in ground wires.
2. Take care when driving the staples onto the ground wires to avoid damaging the wire.
3. If space allows, 2' spacing allows installation with 2 man crew instead of 3 in some areas.

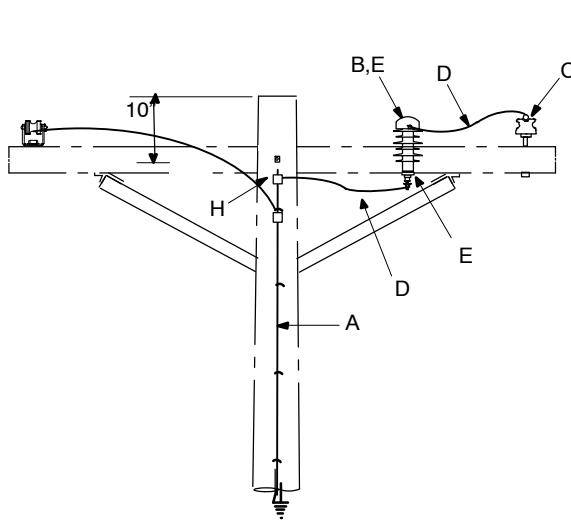
		Std. / Stk. No.	Description	12 04 01 **	04
					3 Ph
@	A	12 00 10 **	Grounding Unit		1
	B	10 01 133	Arrester, 3kV		3
	C	18 51 021	Wire, Cu, #6 S.D., Poly Covered (Ft.)		23
	D	17 58 054	Bracket, Crossarm		3
	E	04 00 20 01	Crossarm, 6' (Use only 1/2 of V-brace)		1
	G	HLC*W	Clamp, Hot Line		3
	J	17 54 004	Connector, Elect., Split Bolt		1

LIGHTNING PROTECTION AND GROUNDING

Lightning Arrester Installation
4-15 kV – Existing Circuit

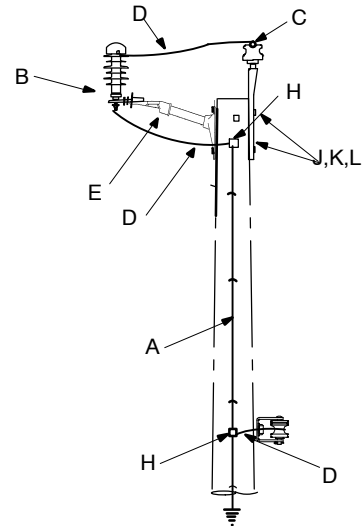
12 12 01 **

Sheet 1 of 5



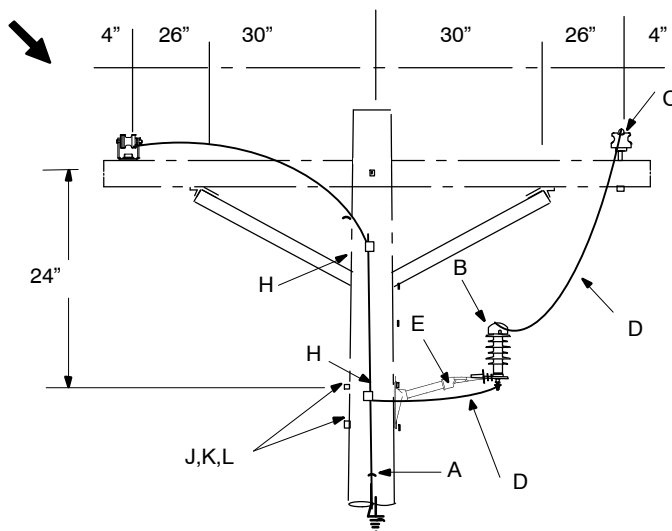
12 12 01 01

AMEREN MO



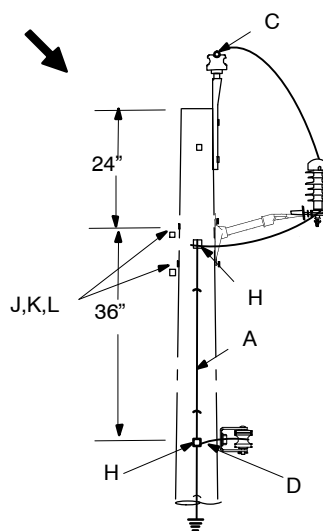
12 12 01 03

AMEREN MO



12 12 01 02

AMEREN IL



12 12 01 04

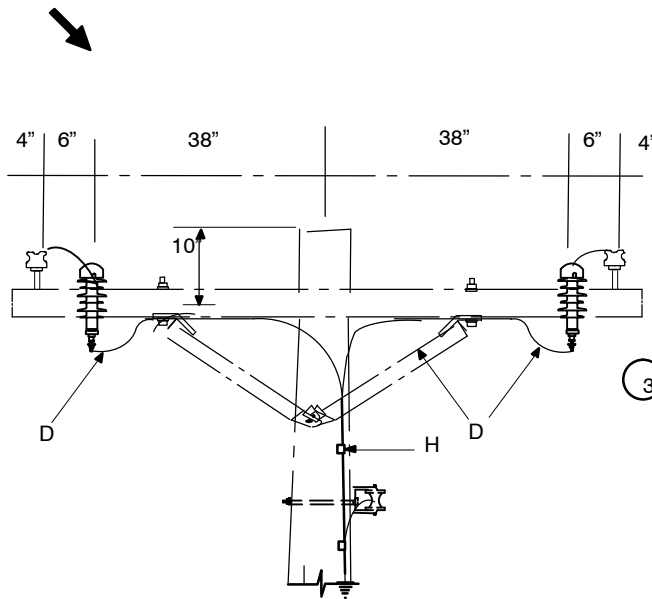
AMEREN IL & MO

LIGHTNING PROTECTION AND GROUNDING

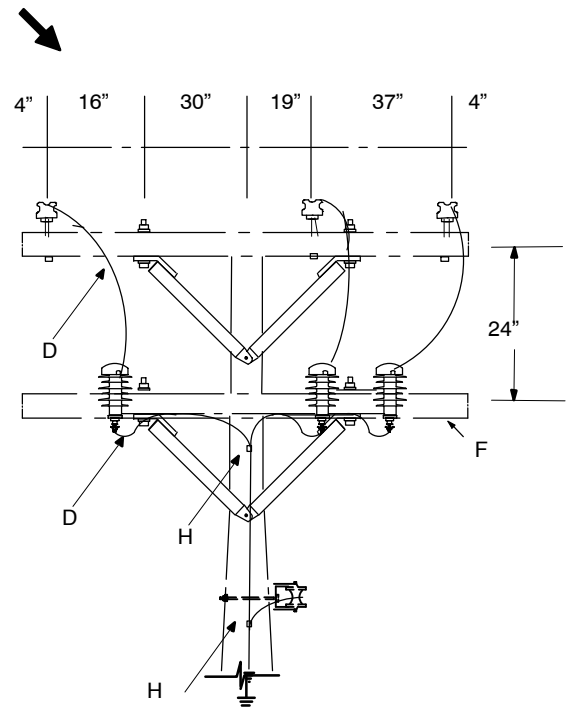
Lightning Arrester Installation
4-15 kV – Existing Circuit

12 12 01 **

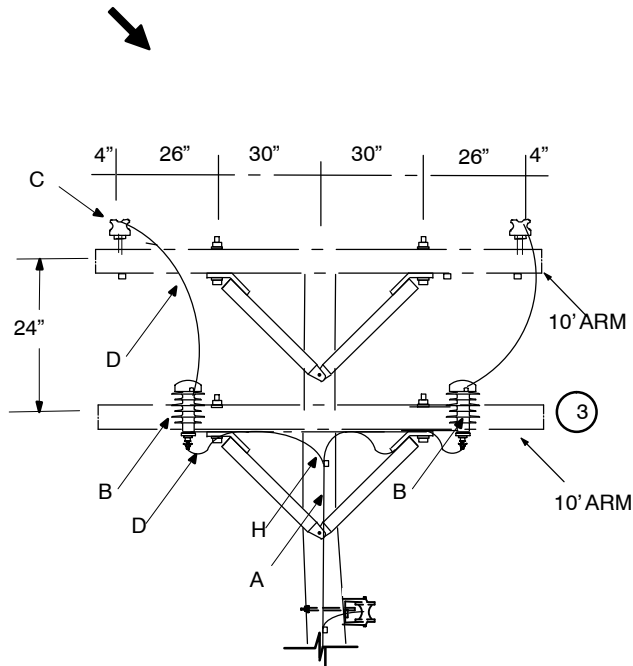
Sheet 2 of 5



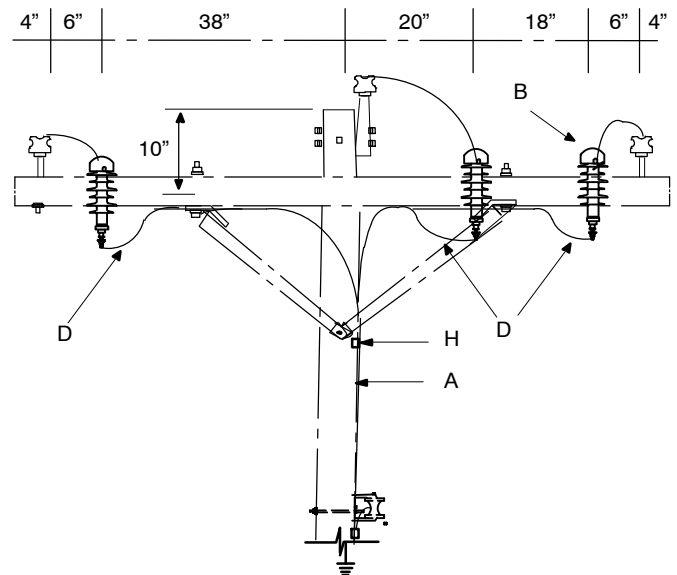
12 12 01 05
AMEREN MO



12 12 01 07
AMEREN IL & MO



12 12 01 06
AMEREN IL & MO



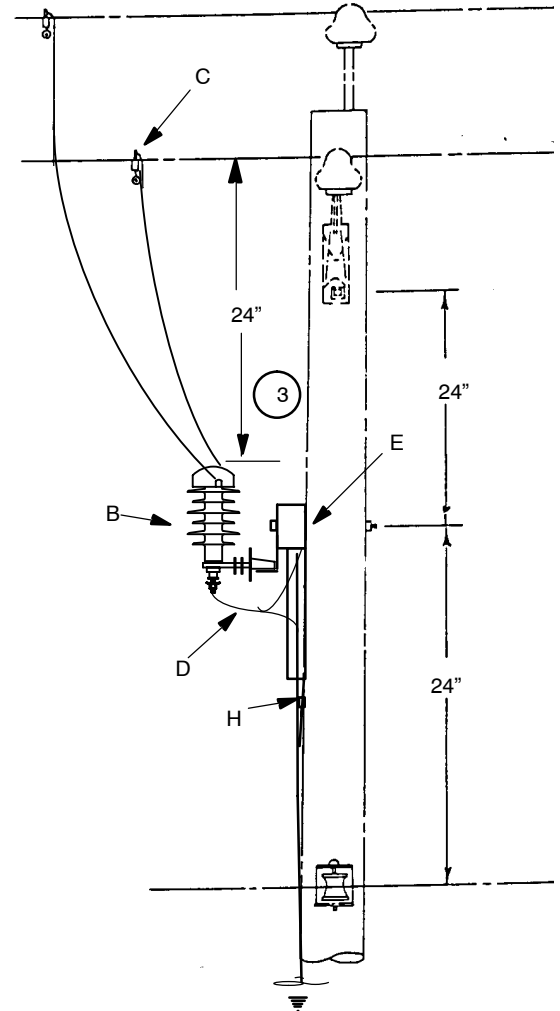
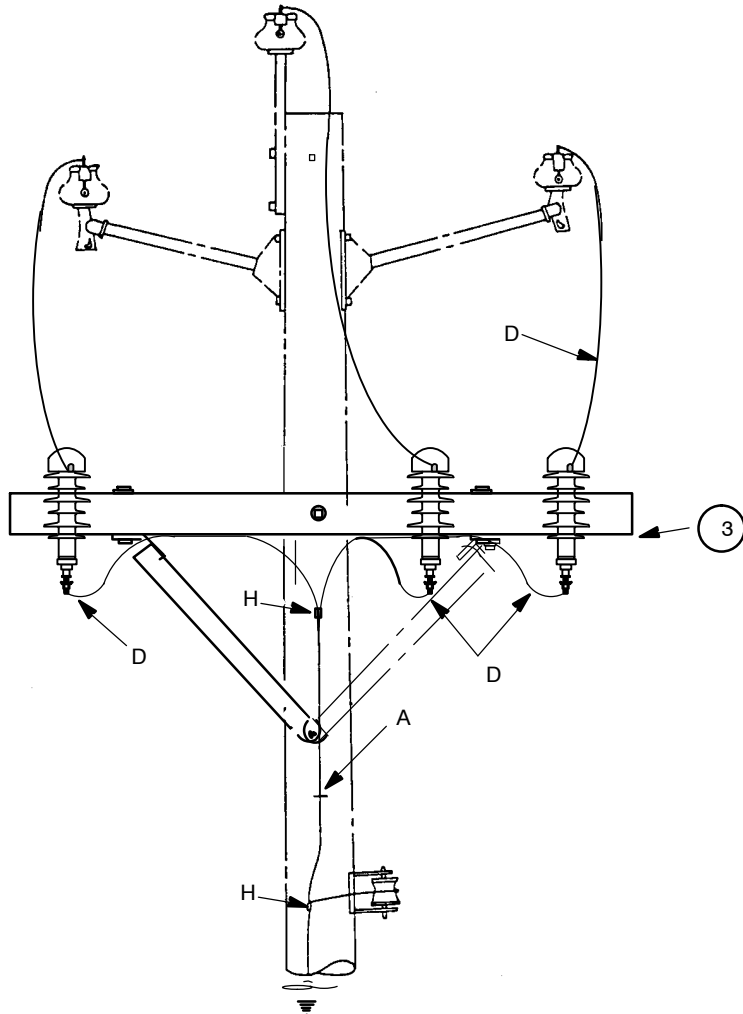
12 12 01 08
AMEREN MO

LIGHTNING PROTECTION AND GROUNDING

Lightning Arrester Installation
4-15 kV – Existing Circuit

12 12 01 **

Sheet 3 of 5



12 12 01 09 – 10 FT CROSSARM – AMEREN IL&MO

12 12 01 10 – 6 FT CROSSARM – AMEREN MO

LIGHTNING PROTECTION AND GROUNDING**Lightning Arrester Installation
4–15 kV – Existing Circuit****12 12 01 ****

Sheet 4 of 5

NOTES:

1. Route the ground wires in a straight line or a smooth curve. Avoid making sharp bends in ground wires.
2. Take care when driving the staples onto the ground wires to avoid damaging the wire.
3. For IL, arresters must be installed on separate arm – 10 ft, For MO, if space allows, arresters on separate arm allows installation with 2 man crew instead of 3 in some areas.
4. Arresters Selection, Refer to DCS 12 00 01 01 – Table 1.

		Std. / Stk. No.	Description	12 12 01 **	01	02	03	04	05
					1 Ph	1 Ph	1 Ph	1 Ph	2Ph
@ 4 @	A	12 00 10 **	Grounding Unit		1	1	1	1	1
	B	10 01 133	Arrester, 3kV, MCOV		1	1	1	1	2
		10 01 144	Arrester, 8.4kV MCOV		1	1	1	1	2
		10 01 188	Arrester, 12.7kV MCOV		1	1	1	1	2
10 01 008		Arrester, 10.2kV MCOV		1	1	1	1	2	
@	C	HLC*W	Clamp, Hot Line – DCS 07 00 21 00		1	1	1	1	2
	D	18 51 021	Wire, Copper, #6 SD Poly Covered (ft)		10	10	6	6	12
	E	17 58 054	Bracket, Crossarm, Arr.		1				2
	G	23 06 127	Bracket, Fiberglass, Switch and Arrester			1	1	1	
	F	04 00 20 01	Crossarm, 6'						
	I	04 00 20 03	Crossarm,10'						
	H	17 54 373	Connector, Elect., Split bolt		2	2	2	2	2
	J	23 52 095	Bolt, Machine, 3/4" x 10" w/Sq Nut			2	2	2	
	K	23 66 027	Washer, Square, 3/4" Bolt			4	4	4	
	L	23 65 042	Nut, Lock, Square, Galv, ¾"			2	2	2	
	M	PG**	Clamp, Parallel Groove – DCS 07 00 25 00		1	1	1	1	1

LIGHTNING PROTECTION AND GROUNDING

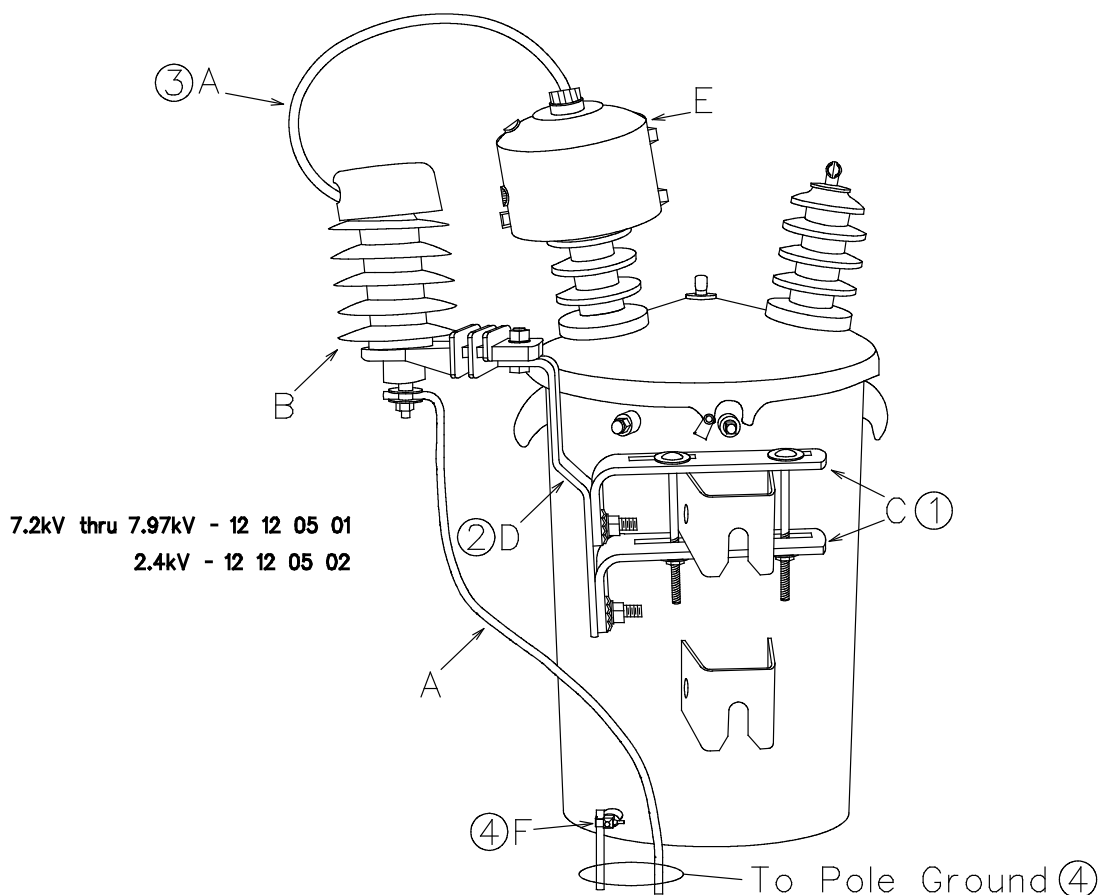
Lightning Arrester Installation
4–15 kV – Existing Circuit

12 12 01 **

Sheet 5 of 5

		Std. / Stk. No.	Description	12 12 01 **	06	07	08	09	10
					2 Ph	3 Ph	3 Ph	3 Ph	3 Ph
@ 4 @	A	12 00 10 **	Grounding Unit		1	1	1	1	1
	B	10 01 133	Arrester, 2.55kV MCOV		2	3	3	3	3
		10 01 144	Arrester, 8.4kV MCOV		2	3	3	3	3
		10 01 188	Arrester, 12.7kV MCOV		2	3	3	3	3
		10 01 008	Arrester, 10.2kV MCOV		2	3	3	3	3
@	C	HLC*W	Clamp, Hot Line – DCS 07 00 21 00		2	3	3	3	3
	D	18 51 021	Wire, Copper, #6 SD Poly Covered (ft)		16	24	20	23	23
	E	17 58 054	Bracket, Crossarm, Arr.		2	3	3	3	3
	G	23 06 127	Bracket, Fiberglass, Switch and Arrester						
	F	04 00 20 01	Crossarm, 6'						1
	I	04 00 20 03	Crossarm, 10'		1	1		1	
	H	17 54 373	Connector, Elect., Split bolt		2	2	2	2	2
	J	23 52 095	Bolt, Machine, 3/4" x 10" w/Sq Nut						
	K	23 66 027	Washer, Square, 3/4" Bolt						
	L	23 65 042	Nut, Lock, Square, Galv, ¾"						
	M	PG**	Clamp, Parallel Groove – DCS 07 00 25 00		1	1	1	1	1

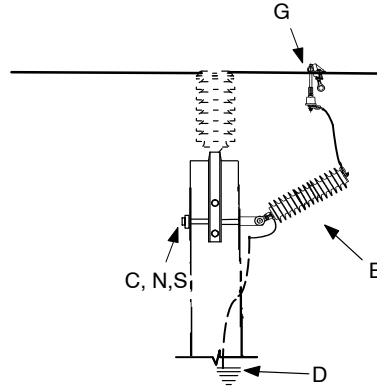
Purpose - This DCS is for mounting arrester adjacent to the H1 bushing on a transformer that does NOT have existing lugs for tank mounting of the arrester. Use when arrester is being moved from Energized Zone to transformer level on existing/older transformer installations.



NOTES

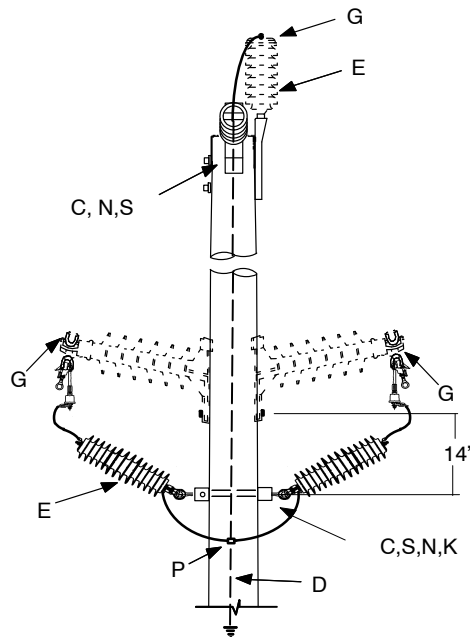
- For transformers with cover mounted primary bushings, install the cutout/arrester crossarm mounting bracket oriented as shown on the top hanger bracket of the transformer.
- Stk. No. 23 06 122 comes with a copper strap that is to be removed and returned to the storeroom for recycling.
- Make sure the wire opening in the arrester cap is oriented away from the mounting bracket.
- Bond the arrester ground directly to the pole ground and use the ground lug to separately bond the tank to pole ground

		Std. / Stk. No.	Description	12 12 05 **	01	02
2	A	18 51 021	Wire, Ground, #6, S.D. Poly covered (Ft.)		7	7
	B	10 01 144	Arrester, 10kV		1	
		10 01 133	Arrester, 3kV			1
	C	23 56 088	Bracket, Crossarm, Cutout/Arrester		1	1
	D	23 06 122	Bracket, L-Shaped, Transformer Mtg., Arrester		1	1
	E	69 58 296	Guard, Wildlife, Clam-Shell, Short		1	1
	F	69 58 121	Ground, Transformer Tank, #8 Sol. To #2 Str. Cu.		1	1



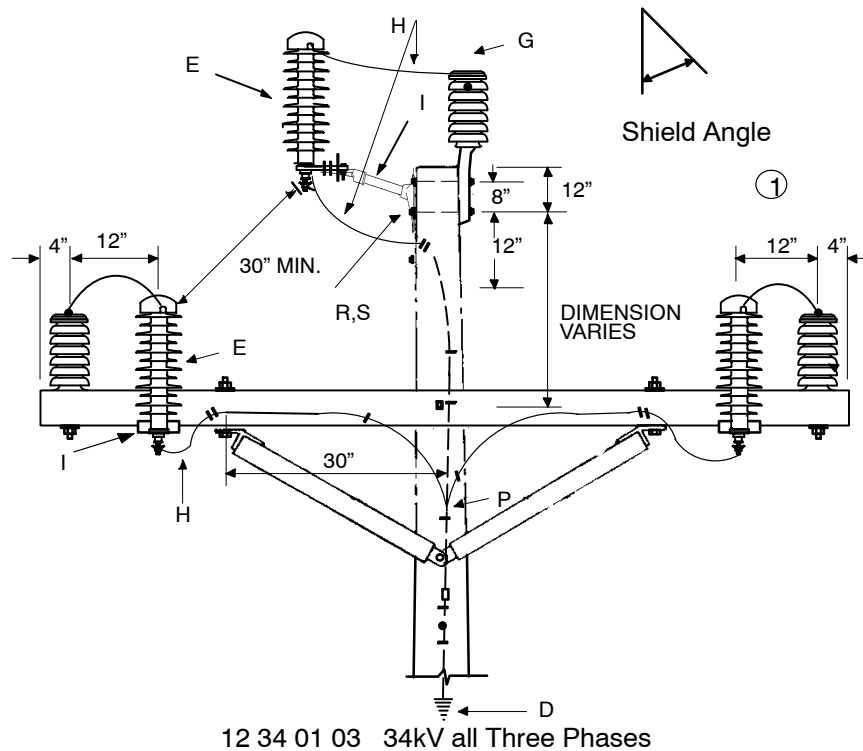
12 34 01 04 69 kV
12 34 01 05 34 kV

TOP PHASE



12 34 01 01 34 kV
12 34 01 06 69 kV

THREE PHASE



NOTES:

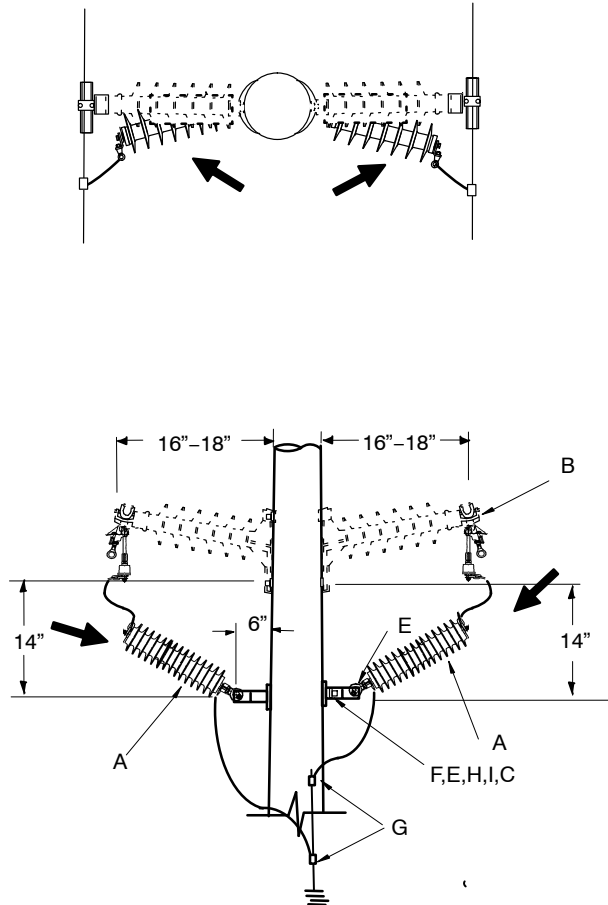
1. If the shield formed by the pole top insulator and the outside crossarm insulator is less than 30 deg., arrester on the top phase only. If the angle exceeds 30 deg., arresters on all three phases.
2. Arresters should be installed on every pole in open ground, every third pole if shielded by trees or buildings.
3. Not for use in new construction. This Standard is only for lightning protection of existing subtransmission configurations.
4. Use double staples to hold ground wire in the event the ground lead isolator blows off. Distance from the double staples to the ground lead isolator should be 6" minimum.
5. Route the ground wires in a straight line or a smooth curve. Avoid making sharp bends in ground wires.
6. Take care when driving the staples onto the ground wires to avoid damaging the wire.
7. Stock #10 01 147 and Stock #10 01 148 are not for new installation.
8. Stock #10 01 239 and stock #10 01 158 are for New installation.

LIGHTNING PROTECTION AND GROUNDING
Lightning Arrester Installation
Single Circuit–Existing 34 & 69 kV (Not for New Construction)

12 34 01 **

Sheet 3 of 3

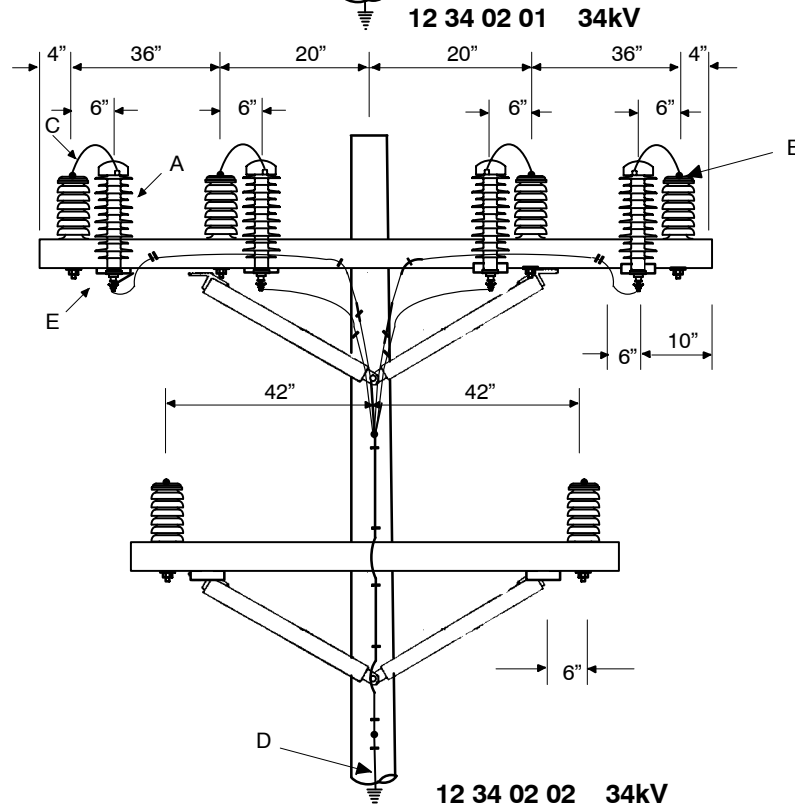
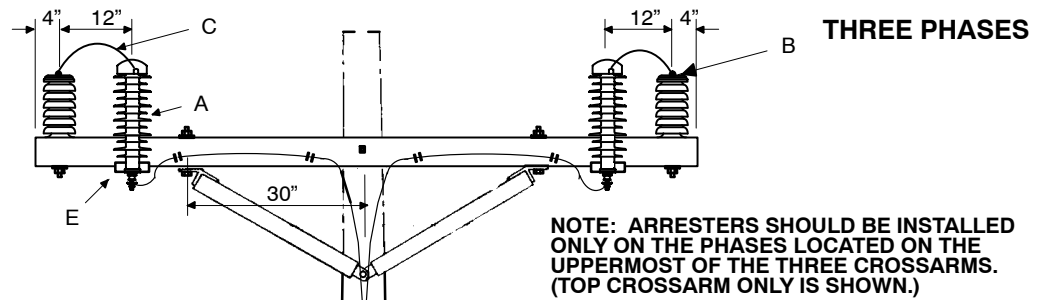
		Std. / Stk. No.	Description	01	03	04	05	06
	C	23 52 097	Bolt, Mach., 3/4" x 12"	1		1	1	1
@	D	12 00 10 **	Grounding Unit	1	1	1	1	1
7	E	10 01 147	Arrester, 30kV, 24.4kV MCOV Crossarm Mt.		2			
7		10 01 148	Arrester, 30kV, 24.4kV MCOV Pole Mt.		1			
8		10 01 158	Arrester, 60kV, 48kV MCOV W/Clevis, Susp			1		3
8		10 01 239	Arrester, 30kV, 24.4kV MCOV, W/Clevis, Susp	3			1	
@	F	HLC*W	Hot Line Clamp DCS 07 00 21 00		3			
@	G	STC*W	Clamp, Stirrup DCS 07 00 21 00	3		1	1	3
	H	18 51 021	Wire, Copper, Poly Covered, #6 S.D.		20			
	I	17 58 054	Bracket, Crossarm, Arrester		2			
		23 06 127	Bracket, fiberglass, Switch and Arrester		1			
	K	23 59 095	Eyelet, 3/4" Bolt	2				2
	L	23 65 018	Eyenuit, 3/4" Bolt	1				1
	N	23 66 031	Washer, Square, Curved 3" x 3" 3/4"	4	4	2	2	4
@	P	P.G.	Clamp, P.G. (see Std. 07 00 25 00)	3		1	1	3
	R	23 53 070	Bolt, Dbl., Arm, 3/4" x 14"		2			
	S	23 65 042	Nut, Lock, Square, Galv, 3/4"	3	4	1	1	3



NOTES:

1. Arresters should be installed on every pole.
2. Items A includes base mounted clevis, tinned copper ground and line terminal leads, disconnect, and hot line clamps. Stirrup clamp on end of line terminal lead need to be ordered separately.
3. Use care when driving staples onto covered pole ground wire to avoid damaging the wire.

		Std. / Stk. No.	Description	12 34 02 **	03	04
2 @ @ @	A	10 01 239	Arrester, 30kV, 24.4kV MCOV Suspended	1	2	
	B	STC*W	Clamp, Stirrup – DCS 07 00 21 00	1	2	
	C	23 53 059	Bolt, DA, 3/4" x 18", HDG w/4 Sq Nuts		1	
	D	12 00 10 **	Grounding Unit	1	1	
	E	23 65 018	Eyenuit, 3/4"		1	
	F	23 66 031	Washer, Square 3/4", Galvanized	2	2	
	G	PG**	Clamp, PG, Bronze – DCS 07 00 25 00	1	2	
	H	23 59 095	Eyelet, 3/4" Bolt	1	1	
	I	23 65 042	Nut, Lock, Square, Galv, 3/4"	1	2	
	J	23 52 097	Bolt, Mach, 3/4: x 12"	1		

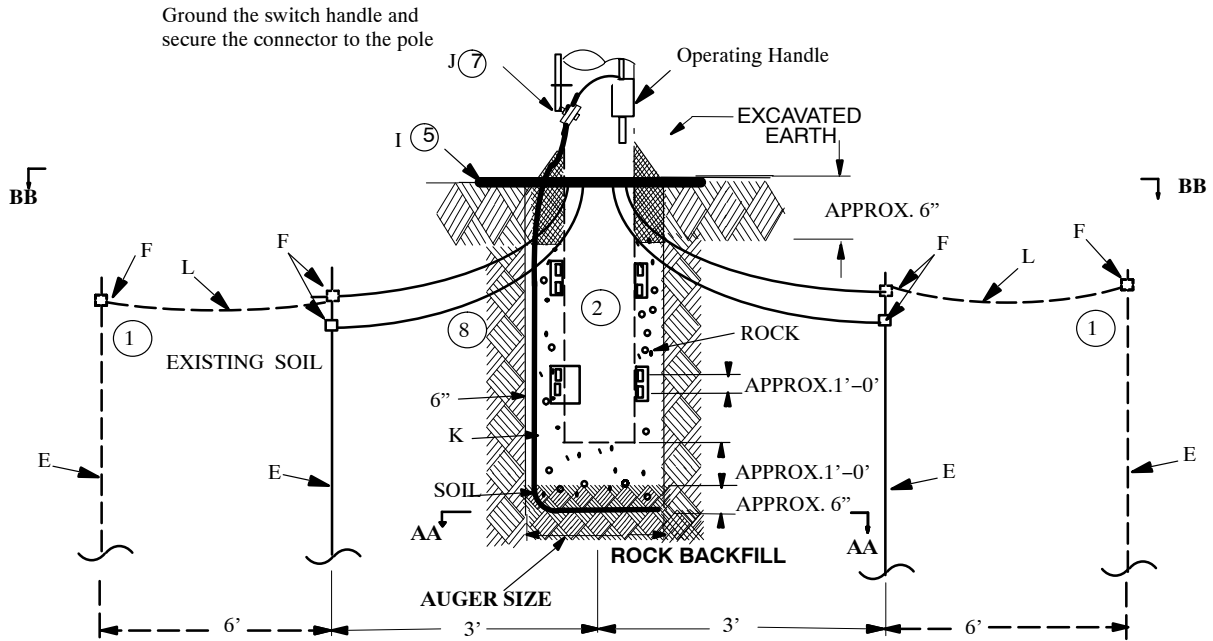


NOTES:

1. Arresters should be installed on every pole
2. Use double staples to hold ground wire in case the ground lead isolator blows off. Distance from the doubles staples to the ground lead isolator should be 6" maximum.
3. Arrange arrester brackets to position arresters low on the cross but not low enough to place the top of the arrester below the phase wire.
4. Route the ground wires in a straight line or a smooth curve. Avoid making sharp bends in ground wires.
5. Use care when driving staples onto covered pole ground wire to avoid damaging the wire.

		Std. / Stk. No.	Description	12 34 02 **	01	02
@	A	10 01 147	Arrester, 30 kV 24.4kV MCOV, Crossarm Mount		2	4
	B	HLC*W	Clamp, Hot Line		2	4
	C	18 51 021	Wire, Copper, Poly Covered, #6 S.D.		15	20
@	D	12 00 10 **	Grounding Unit		1	1
	E	17 58 054	Bracket, Crossarm, Arrester		2	4

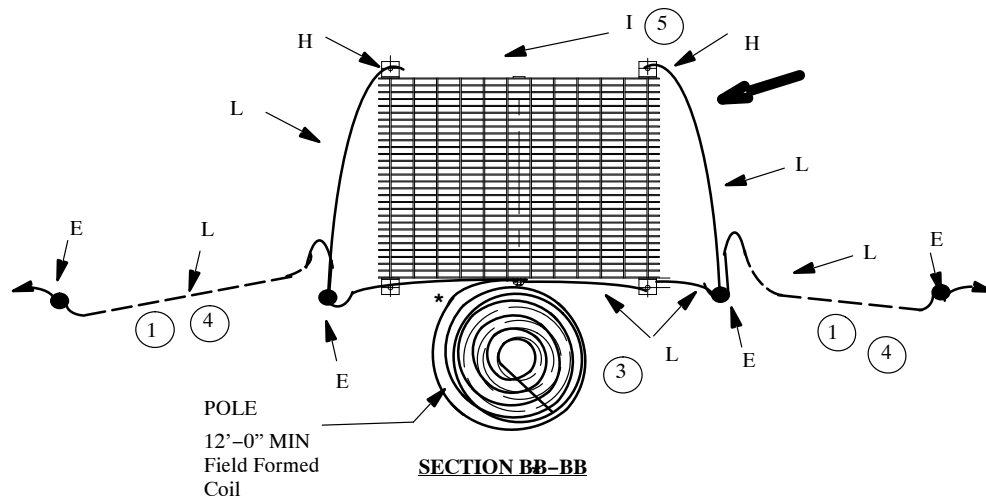
With Ground Mat



12 69 11 01 – Wood Pole with Motor Operator

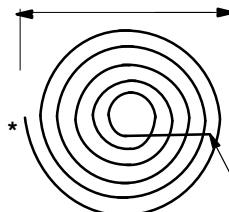
12 69 11 02 – Steel Pole

12 69 11 03 – Composite Pole



SECTION BB-BB

AUGER SIZE

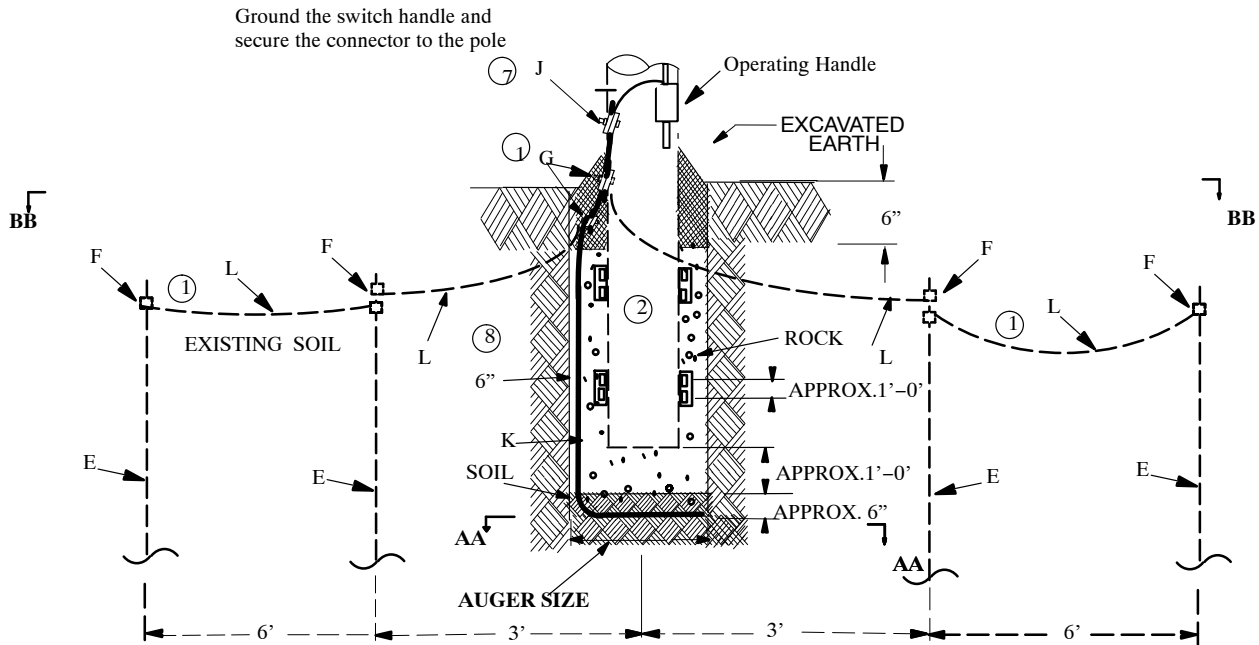


****12'-0" MIN. FIELD FORMED COIL**

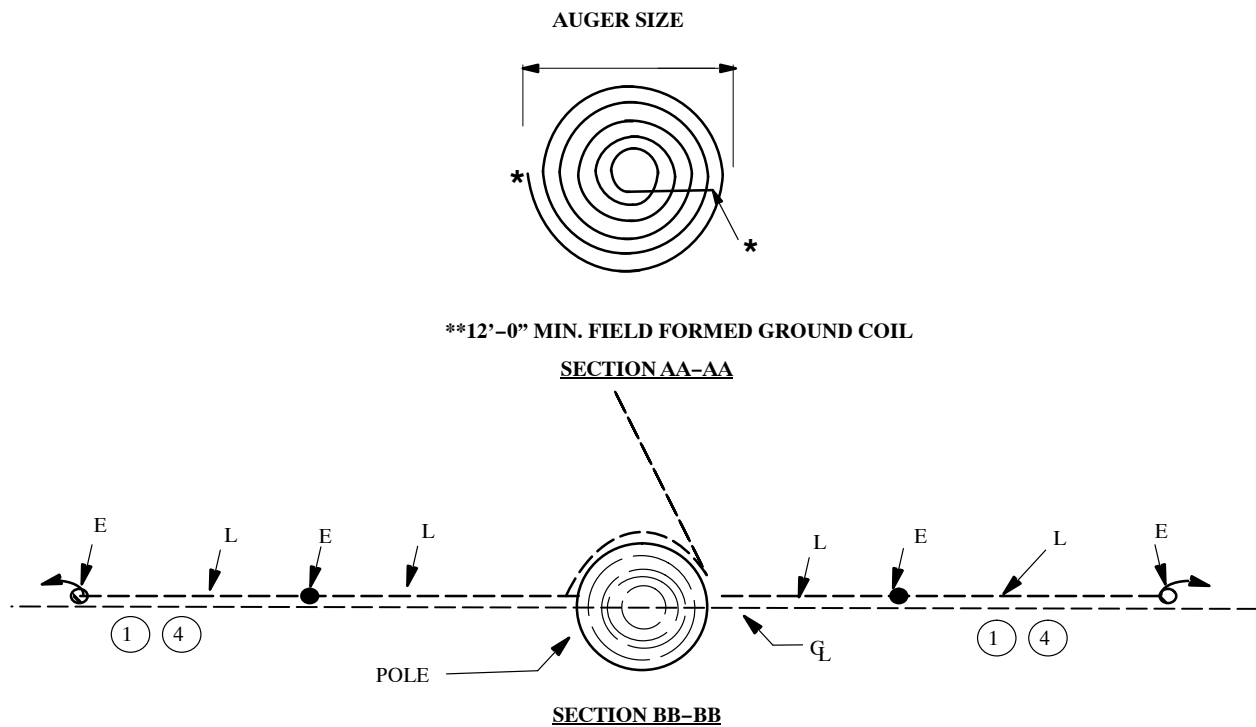
SECTION AA-AA

****12'-0" MIN. FIELD FORMED COIL**

Without Ground Mat



12 69 11 04 – Wood Pole without Motor Operator



NOTES:

1. Ground resistance will normally be less than 25 ohms with one rod. In rocky or sandy soil where experience indicates ground resistance may exceed 25 ohms, install additional rods spaced 6' apart. Doubling the number or length of the rod reduces ground resistance by 40%.
 - a. If additional grounding is needed, terminal poles, a #2 bare copper counterpoise wire 100'–150' long may be placed in the cable trench and connected to the ground lead.
 - b. In rocky soil where driving a rod is difficult – a counterpoise, as stated in a) may be placed in a trench at least 18" deep.
2. Refer to DCS Sections 02 for pole setting depth associated with backfill material and method.
3. Ground mat to be installed under operating handle. Always place some crushed rock on top of ground mat to add better ground support for operating the switch.
4. Ground rods to be installed along conductor center–line if more than one rod is required.
5. Stock #23 17 405 – Above grade grounding platform covers some crashed rocks.
6. For pole grounding requirement, see DCS 10 34 01 01.
7. SEECO switch uses stock #17 52 140 for grounding the operating handle strip.
Turner switch uses stock # 17 51 032 for grounding the operating handle strip.
8. If switch is to be mounted on an existing pole, a driven ground may be used.
9. Ground switch handle for 15kV group operated switch: 12 69 11 05 – Grounding with Rod;
12 69 11 06 – Grounding with coil.

		Std. / Stk. No.	Description	12 69 11 **	01	02	03	04	05	06
6@	A	18 51 019	Wire, #2 Cu Poly Covered – Pole Ground Wire	As Req.			With Pole			
6@	C	23 64 001	Staple – 3/8" for Grd. Wire	10						
1@	E	23 63 027	Rod – Ground 5/8"x8'	2	2	2	2	2	1	
1@	F	17 52 032	Clamp – Grd. Rod. 5/8" for #8 – 1/0	2	2	2	2	2	1	
1@	H	17 52 142	Clamp – PG, #4 Sol. Cu to 2/0 Str. Cu	4	4	4	4	2		
1@	G	17 51 032	Clamp, PG, Grd, #4 Cu to 2/0 Str Cu					2		1
5	I	23 17 405	Ground Platform 4' x 3', Galv. Steel – above grade	1	1	1				
8	K	18 52 025	Wire, Misc. #2 Bare Cu., S.D. – Field Formed Ground Coil (ft.)	30	30	30	30	30		30
7@	J	17 52 140	Clamp, Grounding Cable to Flat #4 Sol Cu to 300MCM Cu	1	1	1	1	1	1	1
		17 51 032	Clamp, PG, Grd, #4 Cu to 2/0 Str Cu	1	1	1	1	1		
1@	L	18 52 025	Wire, Misc. #2 Bare Cu., S.D. – Connection from Ground Rods (ft.)	30	30	30	30	30	2	2
		303	Operation Code, Install Ground Rods	1	1	1	1	1	1	1
		306	Operation Code, Pole Ground	0.5						
		307	Operation Code, Grounding Connection	0.5	0.5	0.5	0.5	0.5		0.5