

# 600 GROUNDING

12/23/2022

~	N	Installation of Grounding Assemblies
C	N1,N2	Basic Units - Grounding
C	N3,N4	Basic Units - Copperweld Grounding - Pole Ground Repair
~	TN0	Static Wire History/Policy
C	TN1	Static Wire Assembly - Tangent and Angle
C	TN2	Static Wire Assembly - In-Line Deadend
C	TN3	Static Wire Assembly - In-Line Double Deadend
C	TN4	Static Wire Assembly - Double Deadend 90°

**N** New Standard  
**R** Redrawn Standard  
**C** Changed Standard  
**~** No Change

## Grounding Installations - Distribution Circuits

The minimum requirements for grounding assemblies are specified in the National Electrical Safety Code (IEEE C2-2017).

Rule #93-A: Copper-clad steel ground without joint or splice, if possible, free from sharp bends and as short as possible.

Rule #93-C-2: Ground for AC distribution shall have not less than 1/5 of the line conductance. (#4 Cu-equivalent copper-clad steel).

Rule #94-B: Driven electrodes, if practicable, shall be below permanent moisture level, minimum size 5/8" x 8', driven eight (8) feet deep. When rod cannot be driven eight (8) feet deep, install second rod on opposite side of pole and interconnect ground wire. The top of the ground rod shall be flush with or below the ground level unless suitably protected.


Rule #97-A: Ground conductors shall be run separately to ground for:

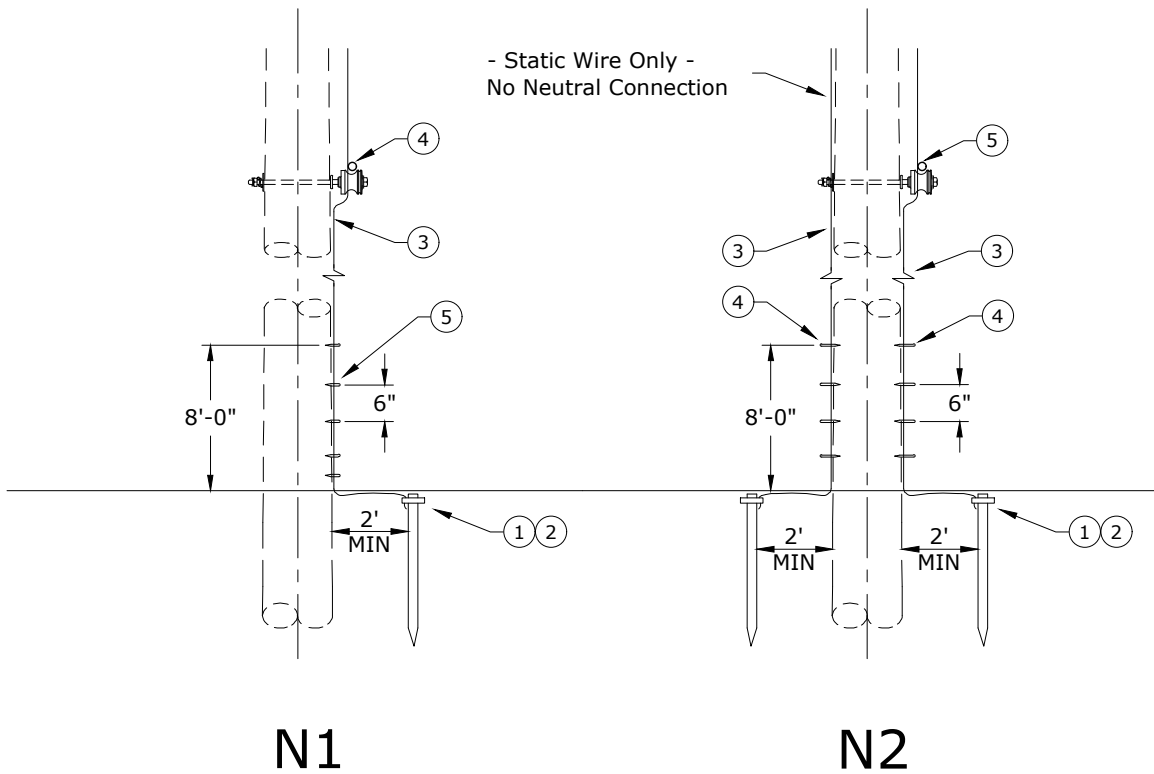
- Surge Arresters over 750v and frames of any equipment operating over 750v (see exceptions below).
- Lighting and power circuits under 750v.
- Shield wires of power circuits

Rule #97-B: An interconnection of primary surge arrester ground and primary and secondary neutral is permitted on a multi-grounded system. This solid interconnection shall be made since surge current is routed through several parallel ground impedances and the danger of insulation damage no longer exists even under conditions of high surge current and high ground impedance.

Rule #215-C: Non-current-carrying parts shall be grounded unless they are 8 feet or more above readily accessible surfaces or they are otherwise isolated or guarded.

Rev. 2 - Updated for 2017 NESC

	<h3 style="margin: 0;">CONSTRUCTION STANDARDS</h3> <p style="margin: 0;">INSTALLATION OF GROUNDING ASSEMBLIES</p>		REVISIONS			
	△	DATE	ENGR	OPS		
	0	4/02	REDRAWN	IN CAD		
	1	11/18/15	KJP			
2	10/27/17	KJP				
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			DATE: 1/31/80			



- Notes:**
1. Staple every 6" from ground line up to 8' above ground.
  2. Top of rod must be below final grade.

Rev 6 - Changed from Cabelok to H-Tap Connector

ITEM NO.	DESCRIPTION	N1	
		QTY	S/N
1	Rod, Ground, 5/8" x 8'	1	1124
2	Clamp, Ground Rod, 5/8", Small, Bronze	1	281
3	Conductor, Copper-Clad Steel, Black w/ Green Stripe, #4 Cu Equivalent, 40% Annealed	40	1512
4	Connector, H-Tap, Al/Cu, Run #2-2/0 Str - Tap #6-#1 Str *	1	413
5	Staple, Ground, Barbed, Galvanized, 1 1/2"	24	2707

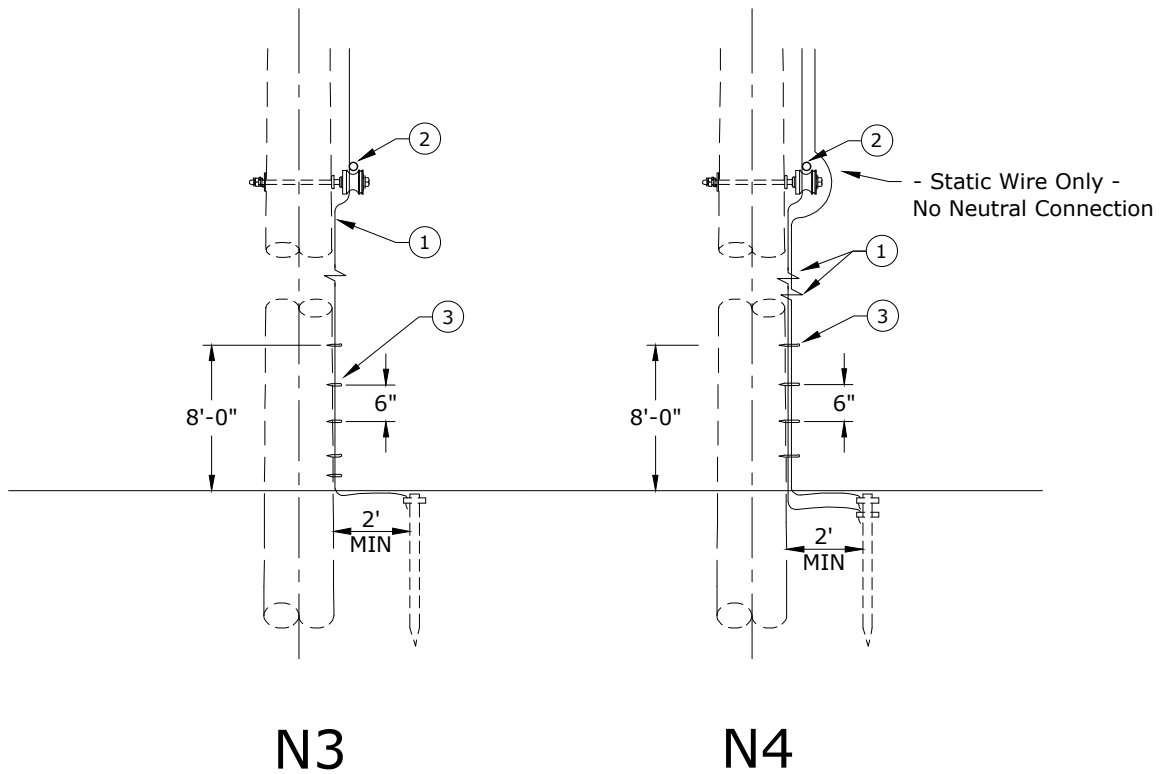
  

ITEM NO.	DESCRIPTION	N2	
		QTY	S/N
1	Rod, Ground, 5/8" x 8'	2	1124
2	Clamp, Ground Rod, 5/8", Small, Bronze	2	281
3	Conductor, Copper-Clad Steel, Black w/ Green Stripe, #4 Cu Equivalent, 40% Annealed	100	1512
4	Staple, Ground, Barbed, Galvanized, 1 1/2"	40	2707
5	Connector, H-Tap, Al/Cu, Run #2-2/0 Str - Tap #6-#1 Str *	1	413



**CONSTRUCTION STANDARDS**  
BASIC UNITS  
GROUNDING

REVISIONS			
DATE	ENGR	OPS	
12/4/14	KJP		
10/27/17	KJP		
9/12/18	KJP		
11/24/22	KJP		



- Notes:**
1. Staple every 6" from ground line up to 8' above ground.
  2. Top of rod must be below final grade.
  3. For N4, the entire static wire does not need to be replaced for the repair. The static wire may be spliced around the height of the neutral. It will depend on how much of the ground wire is missing.

Rev 4 - Changed from Cabelok to H-Tap Connector

ITEM NO.	DESCRIPTION	N3	
		QTY	S/N
1	Conductor, Copper-Clad Steel, Black w/ Green Stripe, #4 Cu Equivalent, 40% Annealed ✱	40	1512
2	Connector, H-Tap, Al/Cu, Run #2-2/0 Str - Tap #6-#1 Str ✱	1	413
3	Staple, Ground, Barbed, Galvanized, 1 1/2"	24	2707

ITEM NO.	DESCRIPTION	N4	
		QTY	S/N
1	Conductor, Copper-Clad Steel, Black w/ Green Stripe, #4 Cu Equivalent, 40% Annealed ✱	72	1512
2	Connector, H-Tap, Al/Cu, Run #2-2/0 Str - Tap #6-#1 Str ✱	1	413
3	Staple, Ground, Barbed, Galvanized, 1 1/2"	24	2707



**CONSTRUCTION STANDARDS**  
BASIC UNITS  
GROUNDING  
POLE GROUND REPAIR

REVISIONS			
Δ	DATE	ENGR	OPS
1	12/4/2014	KJP	
2	10/27/17	KJP	
3	9/12/18	KJP	
4	11/24/22	KJP	

## Static Wire History/Policy

CPU used to install static (shield) wires over transmission lines ½ mile from the substation in all directions.



A change was made to a new style substation surge arrester. The manufacturers claimed they would eliminate the need for static wires. CPU had experienced failures of existing static wires that fell into the transmission on multiple occasions during ice storms. Operations questioned the need for static wires. The decision was made to eliminate in some cases. Operations preferred the THPA standard (which does not allow for static wire) and would like to limit static wire to areas of known lightning problems.

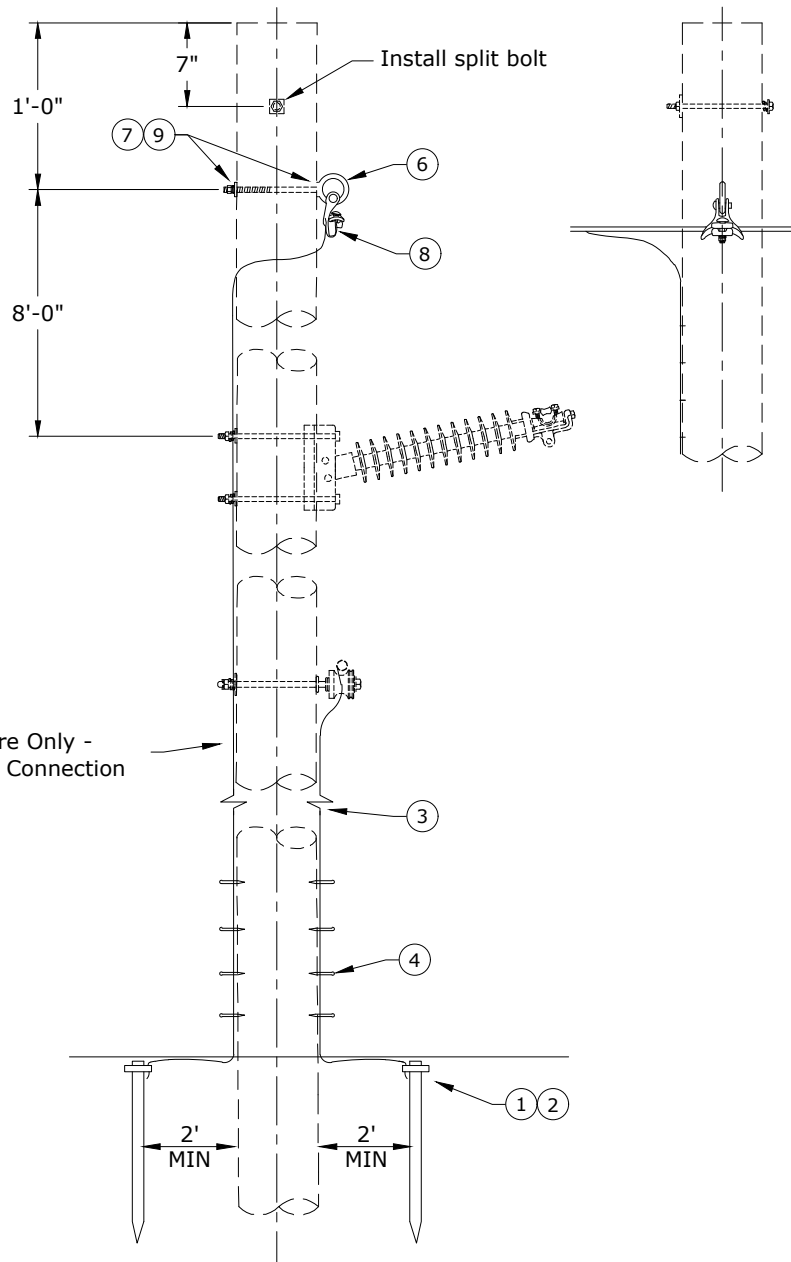
Subsequent information shows that the new surge arresters (90kV) do not completely protect substation transformers as thought. The Chelatchie transformer was damaged by a nearby lightning strike. The surge arrester failed when the line was re-energized.

A determination was made to install static wires out ½ mile from substations when possible but each case would be examined individually to see if it made sense. Substation transformers are now approximately \$1 million, and reliability is a customer priority.

Systems Engineering should be consulted before new transmission is designed or maintenance on existing transmission within a ½ mile of the substation is done so the occurrence of lightning in the area of that substation can be evaluated.

K. Perzanowski  
January 9, 2012

	<b>CONSTRUCTION STANDARDS</b> STATIC WIRE HISTORY/POLICY		REVISIONS		
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Rev 3 - Changed from Cabelok to H-Tap Connector

ITEM NO.	DESCRIPTION	TN1	
		QTY	S/N
1	Rod, Ground, 5/8" x 8'	2	1124
2	Clamp, Ground Rod, 5/8", Small, Bronze	2	281
3	Conductor, Copper-Clad Steel, Black w/ Green Stripe, #4 Cu Equivalent, 40% Annealed*	100	1512
4	Staple, Ground Wire, Barbed, Galv. 1 1/2"	40	2707
5	Connector, H-Tap, Al/Cu, Run #2-2/0 Str - Tap #6-#1 Str *	1	413
ITEM NO.	DESCRIPTION	ADDITIONAL MATERIAL	
		QTY	S/N
6	Bolt, Shoulder Eye, 3/4" x 12" Galv., 18,350 lbs. Ultimate Tensile	1	186
7	Washer, Curved, Cast, 4" x 4" x 13/16"	2	1910
8	Clamp, Angle Straight .16-.75, Max Angle = 120°, 11,000 lbs. Ultimate Strength	1	273
9	Washer, Lock, Spring, Double Coil, Galv., 3/4"	2	2218

Clark  
Public  
Utilities



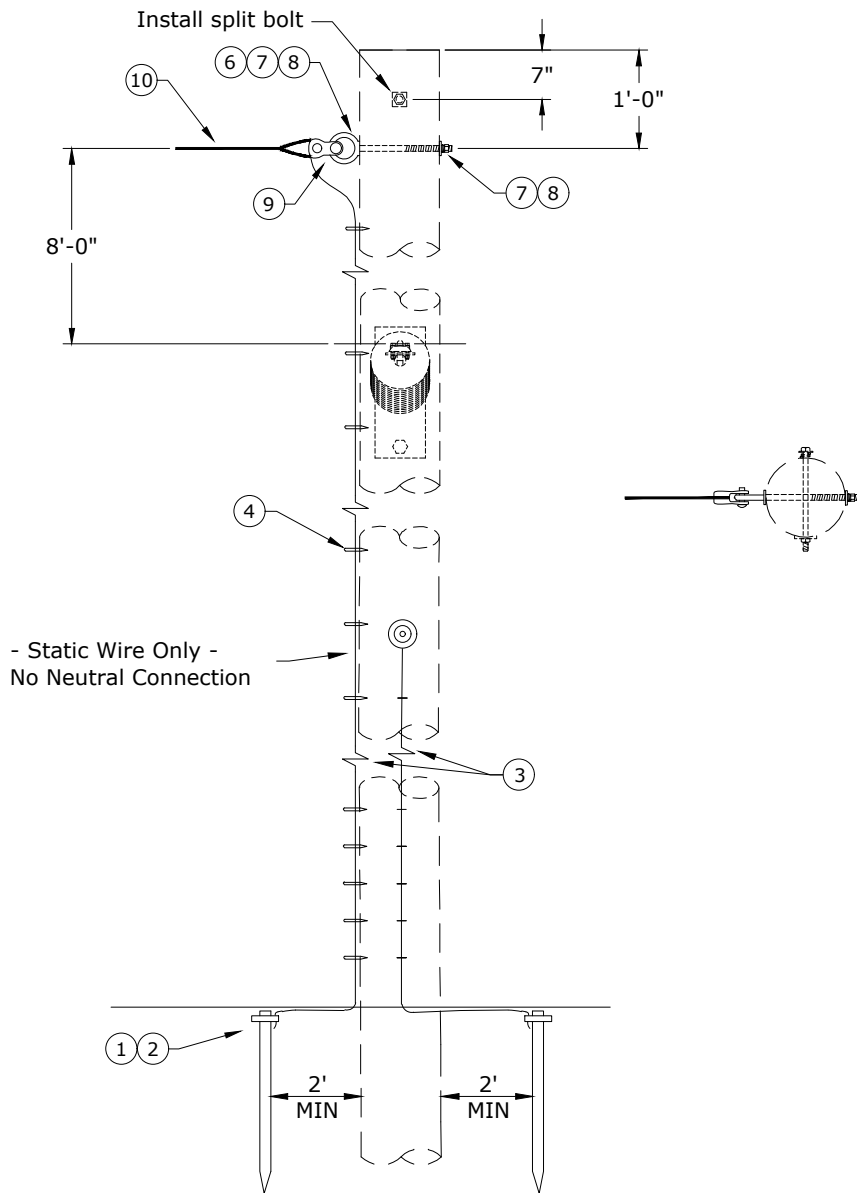
**CONSTRUCTION STANDARDS**  
STATIC WIRE ASSEMBLY  
TANGENT AND ANGLE

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**TN1**

CAD FILE:  
TN1

REVISIONS			
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1	8/01	REDRAWN	IN CAD
2	1/4/17	CM	DK
3	11/24/22	KJP	
APP:		SECTION	
DATE: 5/12/66		<b>600</b>	



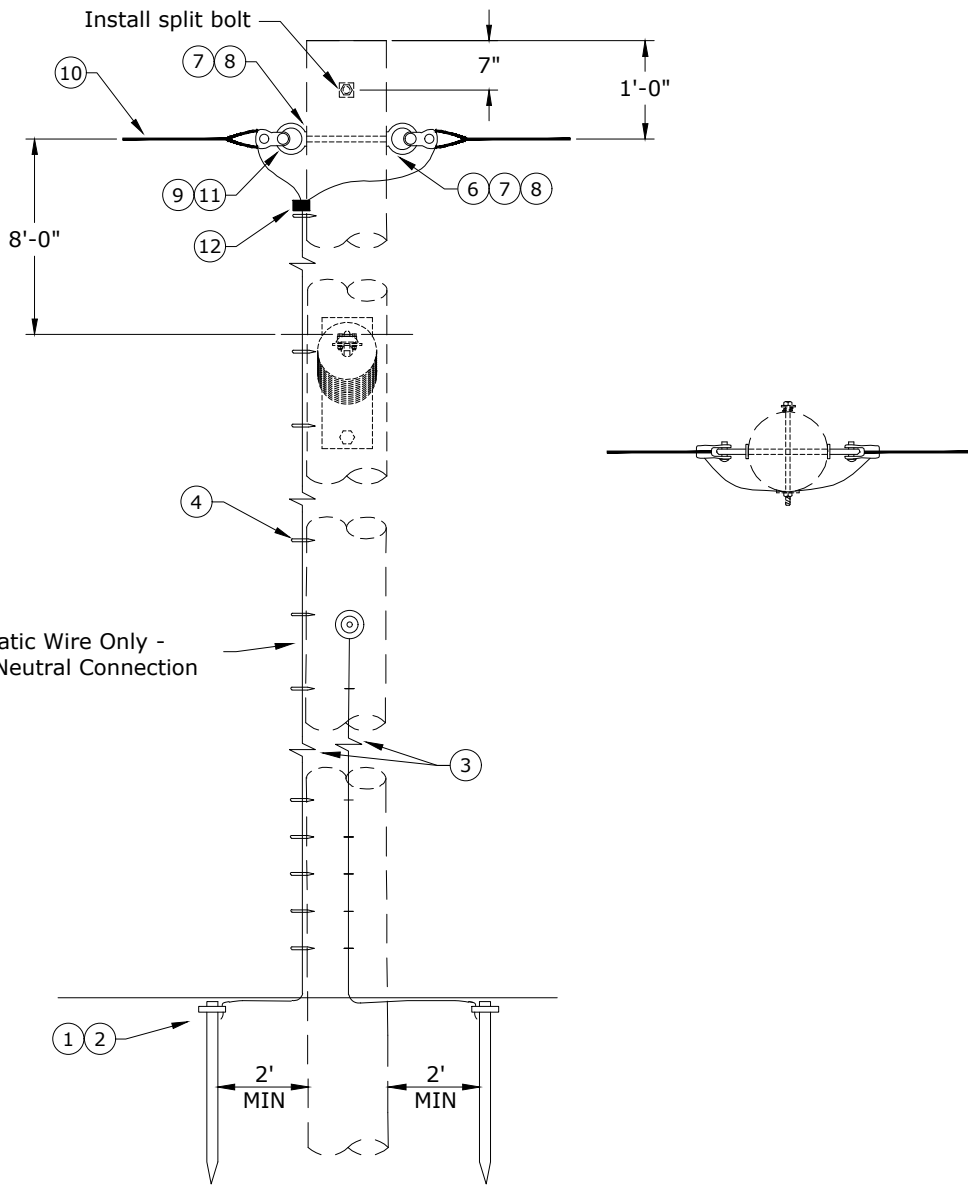
Rev 3 - Changed from Cabelok to H-Tap Connector

ITEM NO.	DESCRIPTION	TN2	
		QTY	S/N
1	Rod, Ground, 5/8" x 8'	2	1124
2	Clamp, Ground Rod, 5/8", Small, Bronze	2	281
3	Conductor, Copper-Clad Steel, Black w/ Green Stripe, #4 Cu Equivalent, 40% Annealed *	100	1512
4	Staple, Ground Wire, Barbed, Galv., 1 1/2"	40	2707
5	Connector, H-Tap, Al/Cu, Run #2-2/0 Str - Tap #6-#1 Str *	1	413
ITEM NO.	DESCRIPTION	ADDITIONAL MATERIAL	
		QTY	S/N
6	Bolt, Shoulder Eye, 3/4" x 12" Galv., 18,350 lbs. Ultimate Tensile	1	186
7	Washer, Curved, Cast, 4" x 4" x 13/16" Hole	2	1910
8	Washer, Lock, Spring, Double Coil, Galv., 3/4"	2	2218
9	Clevis, Thimble, 1 1/4" Dia., 10M Guy	1	1628
10	Grip, Guy, 10M	1	713



**CONSTRUCTION STANDARDS**  
 STATIC WIRE ASSEMBLY  
 IN-LINE DEADEND

REVISIONS			
Δ	DATE	ENGR	OPS
1	8/01	REDRAWN	IN CAD
2	1/4/17	CM	DK
3	11/24/22	KJP	



Rev 3 - Changed from Cabelok to H-Tap Connector

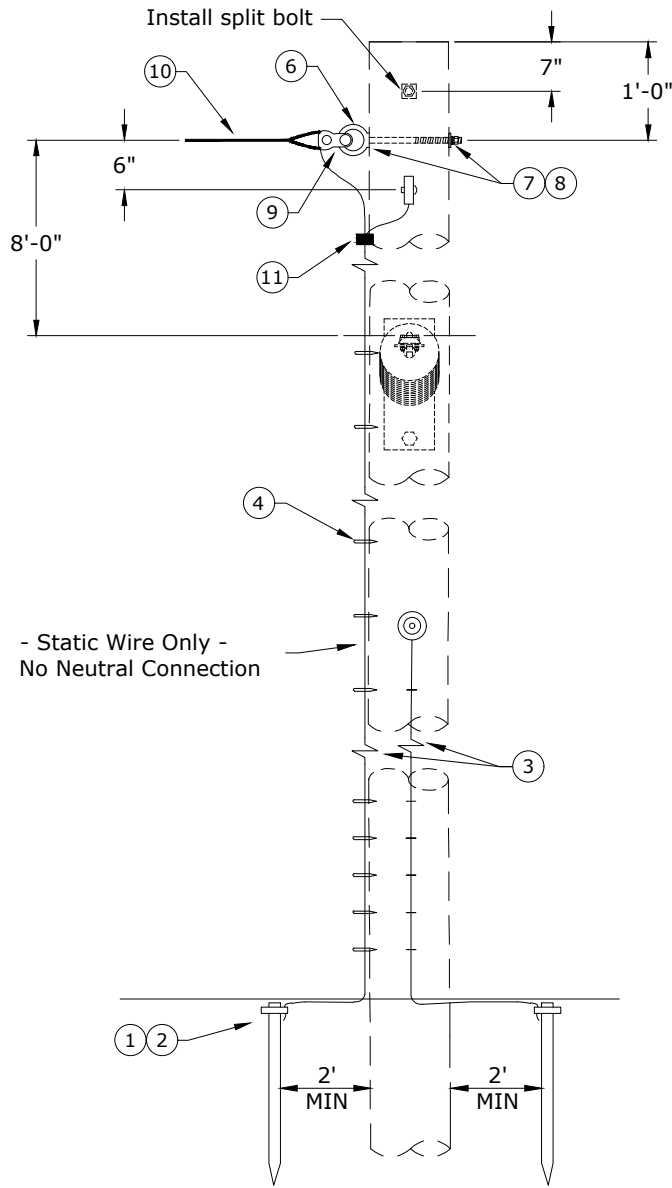
ITEM NO.	DESCRIPTION	TN3	
		QTY	S/N
1	Rod, Ground, 5/8" x 8'	2	1124
2	Clamp, Ground Rod, 5/8", Small, Bronze	2	281
3	Conductor, Copper-Clad Steel, Black w/ Green Stripe, #4 Cu Equivalent, 40% Annealed *	100	1512
4	Staple, Ground Wire, Barbed, Galv., 1 1/2"	40	2707
5	Connector, H-Tap, Al/Cu, Run #2-2/0 Str - Tap #6-#1 Str *	1	413
ITEM NO.	DESCRIPTION	ADDITIONAL MATERIAL	
		QTY	S/N
6	Bolt, Shoulder Eye, 3/4" x 14" Galv., 18,350 lbs. Ultimate Tensile	1	187
7	Washer, Curved, Cast, 4" x 4" x 13/16" Hole	2	1910
8	Washer, Lock, Spring, Double Coil, Galv., 3/4"	2	2218
9	Clevis, Thimble, 1 1/4" Dia., 10M Guy	2	1628
10	Grip, Guy, 10M	2	713
11	Nut, Eye, Oval, 3/4" Galv.	1	914
12	Connector, Crimpet, Cu 2/0-1/0 To #2-#6	1	456



**CONSTRUCTION STANDARDS**  
 STATIC WIRE ASSEMBLY  
 IN-LINE DOUBLE DEADEND

REVISIONS			
DATE	ENGR	OPS	
8/01	REDRAWN	IN CAD	
1/4/17	CM	DK	
11/24/22	KJP		





Rev 3 - Changed from Cabelok to H-Tap Connector.

ITEM NO.	DESCRIPTION	TN4	
		QTY	S/N
1	Rod, Ground, 5/8" x 8'	2	1124
2	Clamp, Ground Rod, 5/8", Small, Bronze	2	281
3	Conductor, Copper-Clad Steel, Black w/ Green Stripe, #4 Cu Equivalent, 40% Annealed *	100	1512
4	Staple, Ground Wire, Barbed, Galvanized, 1 1/2"	40	2707
5	Connector, H-Tap, Al/Cu, Run #2-2/0 Str - Tap #6-#1 Str *	1	413
ITEM NO.	DESCRIPTION	ADDITIONAL MATERIAL	
		QTY	S/N
6	Bolt, Shoulder Eye, 3/4" x 12" Galv., 18,350 lbs. Ultimate Tensile	2	186
7	Washer, Curved, Cast, 4" x 4" x 13/16" Hole	4	1910
8	Washer, Lock, Spring, Double Coil, Galv., 3/4"	4	2218
9	Clevis, Thimble, 1 1/4" Dia., 10M Guy	1	1628
10	Grip, Guy, 10M	2	713
11	Connector, Crimpet Cu 2/0-1/0 To #2-#6	1	456



**CONSTRUCTION STANDARDS**  
 STATIC WIRE ASSEMBLY  
 DOUBLE DEADEND  
 90°

REVISIONS			
NO.	DATE	ENGR	OPS
1	8/01	REDRAWN	IN CAD
2	1/4/17	CM	DK
3	11/24/22	KJP	