

Decision No. 82466, Application No. 53140 (Filed February 11, 1972)

In the matter of the Application of SOUTHERN CALIFORNIA EDISON COMPANY for an order amending General Order No. 95, "Rules for Overhead Electric Line Construction," to Provide Rules, with respects to Prestressed Concrete Poles, Structures and Crossarms.

### O P I N I O N

Southern California Edison Company (Edison) seeks an order amending General Order No. 95, to provide rules, with respect to pre- stressed concrete poles, structures and crossarms.

General Order No. 95 contains rules and safety factors for the use of reinforced concrete poles but it presently contains no references to prestressed concrete poles or structures In order to keep the rules, standards and specifications of General. Order No. 95 up to date, there is a need to amend certain portions of the order to include prestressed concrete. In cooperation with major California electric utilities, the Commission staff and other interested parties, proposed modifications and amendments have been developed by Edison to establish appropriate minimum strength requirements for prestressed concrete poles, crossarms and structures. The proposed modifications and additions to Section IV of General Order No. 95 appear in the Appendix attached hereto.

Edison states that prestressed concrete poles, crossarms and structures are manufactured according to specifications set forth by the American Concrete Institute. Very high strength steel is specified for use in reinforcing rods and prestressing tendons. The concrete is also a special high strength mix. Dimensional variations are held to very close tolerances so that strength characteristics of prestressed concrete items are uniform. Edison states that prestressed concrete poles are highly resistant to weathering because the prestress prevents the formation of cracks which would allow moisture to reach the reinforcing steel. This lack of cracks also makes prestressed concrete resistant to the effects of freezing and thawing. Prestressed concrete poles have been used heavily in Japan and Germany where they have been found to be highly durable. In this country, the durability of prestressed concrete has been proven through many years of experience in bridge structures, where weather and exposure conditions are similar to those experienced by power poles.

Edison claims that because of the structural difference between prestressed concrete and reinforced concrete, considerably lower safety factors can safely be utilized for prestressed concrete.

When Edison filed this application in 1972, it intended only limited uses for concrete poles such as in areas where danger from brush fires existed. Now it appears that prestressed concrete poles may be economical substitutes for wood poles which are becoming increasingly difficult to obtain.

Edison states in its letter of December 24, 1973, that the average cost of a 50-foot wood pole has increased by \$32, from \$115 to \$147, during the past year. The approximate cost of a 15-meter (49.2 feet) prestressed concrete pole is \$156. This concrete pole has a higher usable strength and a longer probable service life.

The proposed modifications to General Order No. 95 set forth in the Appendix have been submitted to and reviewed by:

Department of Water and Power, City of Los Angeles  
Pacific Power and Light Company  
Pacific Gas and Electric Company San Diego Gas & Electric  
Company  
Sacramento Municipal Utility District  
International Brotherhood of Electrical Workers  
Continental Telephone Company of California General Telephone  
Company of California  
The Pacific Telephone and Telegraph Company

Each of the above has advised Edison that it concurs in and endorses the proposed modifications to the General Order.

The Commission finds that the proposed amendment will not be detrimental to the safety of the general public and will establish uniform requirements, the application of which will help insure adequate service and promote safety to persons engaged in the construction, maintenance, operation, or Use of prestressed concrete poles, crossarms, or structures, and concludes that General Order No. 95 should be amended to the extent set forth in the Appendix,

A public hearing is not necessary.

### O R D E R

IT IS ORDERED that General Order No. 95, "Rules for Overhead Electric Line Construction," is hereby amended to the extent set forth in the Appendix attached hereto.

IT IS FURTHER ORDERED that the Secretary shall cause a copy of this order and its Appendix to be served Upon each electric and telephone utility subject to the jurisdiction of this Commission, State Division of Industrial Safety, and, further, to cause a suitable number of copies to be made available for distribution to such other agencies furnishing utility service, and the general public as may request the same.

The effective date of this order is the date hereof.

Dated at San Francisco, California, this 13<sup>th</sup> day of February, 1974

APPENDIX

The Commission's General Order No. 95 shall be amended as follows:

1. The second paragraph of Rule 44, SAFETY FACTORS, will be amended to include a provision for Rules 48.3A and 48.3B, and shall read as follows:

"The safety factors for structural materials other than wood (towers, poles and crossarms) shall be applied as specified in Rule 48.2, 48.3A and 48.3B," and

2. There will be an additional to Rule 44.1, Table 4, SAFETY FACTORS, following the provisions "Crossarms (wood)," to read as follows

Element of Line	Grades of Construction			
	Grade "A"	Grade "B"	Grade "C"	Grade "F"
*****				
*****				
*****				
Prestressed Concrete Poles, Structures, and Crossarms	1.8	1.5	1.5	- -

3. The title of RULE 48.3, REINFORCED CONCRETE, will be amended to read RULE 48.3A, REINFORCED CONCRETE

RULE 48.3-B, PRETESSED CONCRETE, will be added to this section and shall read as follows:

"Structural Members and their connections shall he designed and constructed so that the structures and parts thereof will not fail or be seriously distorted at any load less than their maximum working loads (developed under the current construction arrangements with loadings as Specified in Rule 43) multiplied by the safety factor specified in Rule 44."

"The minimum strength of the materials used in prestressed concrete structures used in conjunction with the safety factors given in Table 4 shall be as follows:

Reinforcing Steel - yield strength 40,000 lb.. per sq. inch  
 Prestressing Steel - yield strength 188,000 lbs. per sq. inch  
 Concrete - compressive strength 4,000 lbs. per sq. inch  
 at 28 days

"Other strength Values may be used provided the strength values used for design are proven by tests."

4. The second paragraph under subsection A. S~TB, of Rule 49.1, POLES, TOWERS AND OTHER STRUTURES, will be amended to include "prestressed concrete" and will read, in part, as follows:

"Metallic, prestressed concrete and reinforced concrete poles, towers. . . etc."

The third paragraph under subsection C. SETTING OF POLES of RULE 49.1, POLES, TOWERS AND OTHER STRUCTURES, will be amended to include "prestressed concrete" and will read, in part, as follows:

"Metallic and prestressed concrete poles that are set. . . etc. . "

5. A third section wlll be added to subsection A. MATERIAL *of* RULE 49.2, CROSSARMS, and will read as follows:

"(3) Prestressed Concrete - Prestressed concrete crossarms may be used provided they are designed in accordance with Rule 48.3B."

A third section will be added to subsection B. MINIMUM SIZE *of* RULE 49.2, CROSSARMS, and will read as follows:

"(3) Prestressed Concrete - The minimum dimension of any prestressed concrete member shall be 3 inches."

**Original Version**  
Rule 44

44 Safety Factors

The safety factors specified in these rules are the minimum allowable ratios of ultimate strengths of materials to maximum working stresses, except that:

The safety factors for structural materials other than wood (towers, poles and crossarms) shall be applied as specified in Rule 48.2, and

The safety factors for wood members in bending shall be applied to longitudinal tension and compression as ratios of the moduli of rupture to the maximum working stresses.

The maximum working stresses used with these safety factors shall be the maximum stresses which would be developed in the materials under the construction arrangement with temperature and loadings as specified in Rule 43.

**Strikeout and Underline Version**  
Rule 44

44 Safety Factors

The safety factors specified in these rules are the minimum allowable ratios of ultimate strengths of materials to maximum working stresses, except that:

The safety factors for structural materials other than wood (towers, poles and crossarms) shall be applied as specified in Rule 48.2, 48.3A and 48.3B, and

The safety factors for wood members in bending shall be applied to longitudinal tension and compression as ratios of the moduli of rupture to the maximum working stresses.

The maximum working stresses used with these safety factors shall be the maximum stresses which would be developed in the materials under the construction arrangement with temperature and loadings as specified in Rule 43.

**Final Version**  
Rule 44

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The maximum working stresses used with these safety factors shall be the maximum stresses which would be developed in the materials under the construction arrangement with temperature and loadings as specified in Rule 43.

**Original Version**  
Rule 44.1

44.1 Installation and Reconstruction,

Lines and elements of lines, upon installation or reconstruction, shall provide as a minimum the safety factors specified in Table 4 for vertical loads and loads transverse to lines and for loads longitudinal to lines except where longitudinal loads are balanced or where there are changes in grade construction (see Rules 47.3, 47.4 and 47.5)

**Table 4**  
**Minimum Safety Factors**

Element of Line	Grade of Construction			
	Grade "A"	Grade "B"	Grade "C"	Grade "F"
Conductors, splices and conductor fastenings (other than tie wires)	2	2	2	1
Pins	2	2	2	1
Pole line hardware	2	2	2	2
Line insulators (mechanical)	3	2	2	2
Guy Insulators (mechanical)				
Interlocking	2	2	2	2
Noninterlocking wood	3	3	3	-----
Noninterlocking glass fiber	3	2(a)	2(b)	-----
Guys, except in light loading districts	2	2	2	1 ½
Guys, in light loading rural districts	2	1 ½	1 ½	1 ½
Messengers and span wires	2	2	2	2
Wood poles	4	3	2	1
Metallic Service and Meter Poles	-	2	2	-
Structural or tubular metallic poles, towers, crossarms and steel members of foundations	1 ½	1 ½	1 ½	-----
Foundations against uplift	1 ½	1 ½	1 ½	-----
Foundations against depression	3	2	2	-----
Reinforced concrete poles	4	3	3	-----
Crossarms (wood)	2	2	2	1

- (a) Insulators are to be replaced before safety factors have been reduced (due to deterioration or changes in construction, arrangement or other conditions subsequent to installation) to less than 95 percent of the safety factor specified in Rule 44.1.
- (b) Insulator are to be replaced before safety factors have been reduced (due to deterioration or changes in construction, arrangement, or other conditions subsequent to installation) to less than 75 percent of the safety factor specified in Rule 44.1.
- (c) For aluminum members subject to tension caused by one or more estimated loads and where the critical load combination for the tension member would not endanger adjacent compression members, the factor of safety on ultimate tension shall be 2 for Grade "A" construction and 1.67 for Grades "B" and "C" construction



**Strikeout and Underline Version**  
Rule 44.1

44.1 Installation and Reconstruction,

Lines and elements of lines, upon installation or reconstruction, shall provide as a minimum the safety factors specified in Table 4 for vertical loads and loads transverse to lines and for loads longitudinal to lines except where longitudinal loads are balanced or where there are changes in grade construction (see Rules 47.3, 47.4 and 47.5)

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Pins	2	2	2	1
Pole line hardware	2	2	2	2
Line insulators (mechanical)	3	2	2	2
Guy Insulators (mechanical)				
Interlocking	2	2	2	2
Noninterlocking wood	3	3	3	-----
Noninterlocking glass fiber	3	2(a)	2(b)	-----
Guys, except in light loading districts	2	2	2	1 ½
Guys, in light loading rural districts	2	1 ½	1 ½	1 ½
Messengers and span wires	2	2	2	2
Wood poles	4	3	2	1
Metallic Service and Meter Poles	-	2	2	-
Structural or tubular metallic poles, towers, crossarms and steel members of foundations	1 ½	1 ½	1 ½	-----
Foundations against uplift	1 ½	1 ½	1 ½	-----
Foundations against depression	3	2	2	-----
Reinforced concrete poles	4	3	3	-----
Crossarms (wood)	2	2	2	1
<u>Prestressed Concrete Poles, Structures, and Crossarms</u>	<u>1.8</u>	<u>1.5</u>	<u>1.5</u>	-----

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- (c) For aluminum members subject to tension caused by one or more estimated loads and where the critical load combination for the tension member would not endanger adjacent compression members, the factor of safety on ultimate tension shall be 2 for Grade "A" construction and 1.67 for Grades "B" and "C" construction

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Guy Insulators (mechanical)				
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Guys, except in light loading districts	2	2	2	1 ½
Guys, in light loading rural districts	2	1 ½	1 ½	1 ½
Messengers and span wires	2	2	2	2
Wood poles	4	3	2	1
Metallic Service and Meter Poles	-	2	2	-
Structural or tubular metallic poles, towers, crossarms and steel members of foundations	1 ½	1 ½	1 ½	-----
Foundations against uplift	1 ½	1 ½	1 ½	-----
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Reinforced concrete poles	4	3	3	-----
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Prestressed Concrete Poles, Structures, and Crossarms	1.8	1.5	1.5	-----

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**Original Version**  
Rule 48.3

48.3 Reinforced Concrete

Values used for ultimate strengths of reinforced concrete, in conjunction with safety factors given in Rule 44, shall not exceed the following:

Reinforcing steel, tensile or compressive strength, pounds per square inch- - - - -55,000

Concrete, 1:2:4 mixture	Age	Compressive Strength
	7 days- - - -	900 lbs per sq in.
	30 days- - -	2,400 lbs per sq in.
	90 days- - -	3,100 lbs per sq in.
	6 mos- - - -	4,400 lbs per sq in.

If reinforced concrete is designed for higher strength values which are proven by test, such values may be used in lieu of the figures given.

## Strikeout and Underline Version

### Rule 48.3

#### 48.3 Reinforced Concrete

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##### B Prestressed Concrete

Structural Members and their connections shall be designed and constructed so that the structures and parts thereof will not fail or be seriously distorted at any load less than their maximum working loads (developed under the current construction arrangements with loadings as Specified in Rule 43) multiplied by the safety factor specified in Rule 44."

The minimum strength of the materials used in prestressed concrete structures used in conjunction with the safety factors given in Table 4 shall be as follows:

Reinforcing Steel - yield strength 40,000 lb.. per sq. inch  
Prestressing Steel - yield strength 188,000 lbs. per sq. inch  
Concrete - compressive strength 4,000 lbs. per sq. inch  
at 28 days

Other strength Values may be used provided the strength values used for design are proven by tests.

**Final Version**  
Rule 48.3

48.3 Concrete

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at 28 days

Other strength Values may be used provided the strength values used for design are proven by tests.

**Original Version**  
Rule 49.1

49.1A Strength

Wood poles shall be of sound timber, free from defects which would materially reduce their strength or durability and they shall have sufficient strength to withstand, with safety factors not less than those specified in Rule 44, the maximum stresses to which they are subjected under the loading conditions specified in Rule 43. The modulus of rupture used in calculation of safety factors shall be not greater than the value given in Rule 48.1.

Metallic and reinforced concrete poles, together with their foundations, shall be of such material and dimensions as to withstand, with safety factors not less than those specified in Rule 44, the maximum stresses to which they are subjected under the loading conditions specified in Rule 43. The fiber stress values used in calculation of safety factors shall be as specified in Rule 48.2 , 48.3 and 48.6.

Certain poles subject to special stresses due to angles in the line, dead – ending of conductors or other attachments, which stresses must be included in computing the loading and safety factor. Poles subject to these special stresses sometimes require the use of guy attachment shall be considered merely as a strut, the guy taking all lateral stresses. In such cases the pole strength requirement shall apply at the point of guy attachment rather than at the ground line.

Spliced or stub reinforced poles or pole top extensions, including the attachment (joint) of the different members involved, shall meet all of the vertical, transverse and longitudinal strength requirements of these rules as if a whole pole were used. Spliced or stub reinforced poles or pole top extensions shall not be used where Grade "A" construction is required in supports of crossings or conflicts, or where Grade "B" construction is required for Class C lines crossing the main lines of major railways.

## Strikeout and Underline Version

### Rule 49.1

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Wood poles shall be of sound timber, free from defects which would materially reduce their strength or durability and they shall have sufficient strength to withstand, with safety factors not less than those specified in Rule 44, the maximum stresses to which they are subjected under the loading conditions specified in Rule 43. The modulus of rupture used in calculation of safety factors shall be not greater than the value given in Rule 48.1.

Metallic, prestressed concrete and reinforced concrete poles, together with their foundations, shall be of such material and dimensions as to withstand, with safety factors not less than those specified in Rule 44, the maximum stresses to which they are subjected under the loading conditions specified in Rule 43. The fiber stress values used in calculation of safety factors shall be as specified in Rule 48.2 , 48.3 and 48.6.

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Spliced or stub reinforced poles or pole top extensions, including the attachment (joint) of the different members involved, shall meet all of the vertical, transverse and longitudinal strength requirements of these rules as if a whole pole were used. Spliced or stub reinforced poles or pole top extensions shall not be used where Grade "A" construction is required in supports of crossings or conflicts, or where Grade "B" construction is required for Class C lines crossing the main lines of major railways.

**Final Version**  
Rule 49.1

49.1A Strength

Wood poles shall be of sound timber, free from defects which would materially reduce their strength or durability and they shall have sufficient strength to withstand, with safety factors not less than those specified in Rule 44, the maximum stresses to which they are subjected under the loading conditions specified in Rule 43. The modulus of rupture used in calculation of safety factors shall be not greater than the value given in Rule 48.1.

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**Original Version**  
Rule 49.1C

49.1C Setting of Wood Poles

The depths of pole settings are given in Table 6 are applicable to wood poles set in firm soil or in solid rock. Where the soil is not firm deeper settings or special methods of pole setting should be resorted to. Where unguayed poles are set subject to heavy strains, or at corners or curves, a greater depth should be used. Guyed poles may be set set not more than one foot less than the depths specified in Table 6 provided the guys do not assume any normal working load under conditions of no wind and the resulting depths of settings are not less than 3 feet.

For communication lines, sawed poles of a cross section of 36 square inches or less may not be set to a depth of 6 inches less than the specifications shown in the following Table.

Metallic poles that are set directly in firm soil or rock shall be set at least as deep as specified in Table 6 for wood poles. Where the resultant bearing surface is not sufficient to prevent over- turning or excessive movement of the pole at the ground line under maximum loading conditions, special measure such as heel and toe bracing, setting in concrete, or bolting to a concrete foundation shall be employed.

Table 6  
Pole Setting Depths

Total length of pole (feet)	Depth in soil (feet)	Depth in Rock (feet)
20-----	-----4-----	-----3
25-----	-----4 1/2 -----	-----3
30-----	-----5-----	-----3
35-----	-----5-----	-----3 1/2
40-----	-----5 1/2 -----	-----3 1/2
45-----	-----6-----	-----4
50-----	-----6 1/2 -----	-----4
55-----	-----7-----	-----4 1/2
60-----	-----7-----	-----4 1/2
65-----	-----7 1/2 -----	-----5
70-----	-----7 1/2 -----	-----5
75-----	-----8-----	-----5 1/2
80-----	-----8-----	-----6

**Strikeout and Underline Version**  
Rule 49.1C

49.1C Setting of Wood Poles

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For communication lines, sawed poles of a cross section of 36 square inches or less may not be set to a depth of 6 inches less than the specifications shown in the following Table.

Metallic and prestressed concrete poles that are set directly in firm soil or rock shall be set at least as deep as specified in Table 6 for wood poles. Where the resultant bearing surface is not sufficient to prevent overturning or excessive movement of the pole at the ground line under maximum loading conditions, special measure such as heel and toe bracing, setting in concrete, or bolting to a concrete foundation shall be employed.

Table 6  
Pole Setting Depths

Total length of pole (feet)	Depth in soil (feet)	Depth in Rock (feet)
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45-----	-----6-----	-----4
50-----	-----6 1/2 -----	-----4
55-----	-----7-----	-----4 1/2
60-----	-----7-----	-----4 1/2
65-----	-----7 1/2 -----	-----5
70-----	-----7 1/2 -----	-----5
75-----	-----8-----	-----5 1/2
80-----	-----8-----	-----6

**Final Version**  
Rule 49.1C

49.1C Setting of Wood Poles

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Metallic and prestressed concrete poles that are set directly in firm soil or rock shall be set at least as deep as specified in Table 6 for wood poles. Where the resultant bearing surface is not sufficient to prevent overturning or excessive movement of the pole at the ground line under maximum loading conditions, special measure such as heel and toe bracing, setting in concrete, or bolting to a concrete foundation shall be employed.

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45-----	-----6-----	-----4
50-----	-----6 1/2 -----	-----4
55-----	-----7-----	-----4 1/2
60-----	-----7-----	-----4 1/2
65-----	-----7 1/2 -----	-----5
70-----	-----7 1/2 -----	-----5
75-----	-----8-----	-----5 1/2
80-----	-----8-----	-----6

**Original Version**

Rule 49.2-A3

49.2-A Material

- (3) New Rule

**Strikeout and Underline Version**

Rule 49.2-A3

49.2-A Material

- (3) **Prestressed Concrete:** Prestressed concrete crossarms may be used provided they are designed in accordance with Rule 48.3-B.

**Final Version**

Rule 49.2-A3

49.2-A Material

- (3) **Prestressed Concrete:** Prestressed concrete crossarms may be used provided they are designed in accordance with Rule 48.3-B.

**Original Version**

Rule 49.2-B3

49.2-B Material

(3) New Rule

**Strikeout and Underline Version**

Rule 49.2-B3

49.2-B Material

(3) **Prestressed Concrete** - The minimum dimension of any prestressed concrete member shall be 3 inches.

**Final Version**

Rule 49.2-B3

49.2-B Material

(3) **Prestressed Concrete** - The minimum dimension of any prestressed concrete member shall be 3 inches.