

Decision No. 24648.

BEFORE THE RAILROAD COMMISSION OF THE STATE OF CALIFORNIA.

In the Matter of the Application of PACIFIC GAS AND ELECTRIC COMPANY, a corporation, GREAT WESTERN POWER COMPANY OF CALIFORNIA, a corporation, SAN JOAQUIN LIGHT AND POWER CORPORATION, a corporation, SOUTHERN CALIFORNIA EDISON COMPANY, LTD., a corporation, LOS ANGELES GAS AND ELECTRIC CORPORATION, a corporation, SAN DIEGO CONSOLIDATED GAS AND ELECTRIC CORPORATION, a corporation, and SOUTHERN SIERRAS POWER COMPANY, a corporation, for an order of the Railroad Commission of the State of California amending and revising the provisions of GENERAL ORDER No. 64-A to the extent necessary to permit the use of a common primary and secondary grounded neutral wire on four-wire overhead distribution systems of 5000 volts or less.

ORIGINAL

Application No. 17805

C. P. Cutten, for Pacific Gas and Electric Company, Great Western Power Company, San Joaquin Light and Power Corporation.

James G. Marshall, for The Pacific Telephone and Telegraph Company and Southern California Telephone Company.

STEVENOT, COMMISSIONER:

O P I N I O N

This is an application of the Pacific Gas and Electric Company, et al., requesting certain revisions of General Order No. 64-A, rules for overhead line construction, in order to permit the installation of common primary and secondary grounded neutral distribution systems of voltages, not exceeding 5000, within the State of California. A public hearing on this matter was held at San Francisco on March 24, 1932. Installation of common primary and secondary grounded neutral systems was urged by the interested parties mainly on the basis of added economies in construction and personal safety to persons engaged in the construction, maintenance, operation, or use of overhead electric lines and to the public in general.

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The Pacific Gas and Electric Company presented certain per-

inent data relative to the effect on telephone plant, safety features and resulting economies, and recommendations believed to be expedient. Included in the recommendations are tentative practices for the purpose of governing inductive coordination between the power and communication utilities to be followed in conjunction with the requirements of General Order No. 52 of this Commission. These practices submitted as a part of the record are not applicable to power distribution systems other than systems of voltages of 5000 or less; to long open wire telephone lines or to telegraph lines, and are binding only to the extent where not superseded by future practices mutually agreed upon by all interested parties.

Evidence was introduced by the Engineering Department of the Commission setting forth the development of common primary and secondary grounded neutral system in the State of California and dealing at length with the various problems attendant upon the installation of this type of distribution system which include the effects on telephone plant, safety features and resulting economies.

Installation of a common primary and secondary grounded neutral distribution system of 5000 volts or less necessitates certain revisions and additions to existing rules covering overhead line construction, as contained in General Order 64-A of this Commission. These revisions and additions were prepared by the Engineering Department of the Commission and submitted in evidence at the hearing in this proceeding in the form of an exhibit.

The consensus of opinion of all interested parties present was favorable to installation of common primary and second-

ary grounded distribution systems of 5000 volts or less. All the evidence indicates that the application of the proposed changes to General Order No. 64-A will result in economies in construction and will not be detrimental to safety of persons or quality of service rendered.

I recommend the following order:

O R D E R

An application having been filed by the Pacific Gas and Electric Company, et al, requesting that the necessary changes and additions to existing rules of General Order No. 64-A be made in order to provide for the installation of common primary and secondary grounded neutral systems of 5000 volts or less, a public hearing having been held and the matter having been submitted and ready for decision,

The Railroad Commission of the State of California Hereby Finds as a Fact that the proposed rules and practices submitted in evidence in this proceeding are reasonable and just, will result in economies in construction, and will not be detrimental to safety of persons or quality of service rendered.

Basing its Order on the foregoing finding of fact,

IT IS HEREBY ORDERED that all installations of common primary and secondary grounded neutral systems of voltages of 5000 or less shall conform to the rules for overhead electric line construction prescribed by the Railroad Commission of the State of California in its General Order No. 64-A and supplement, particularly described in Exhibit "A" attached hereto and made a part of these findings.

The tentative practices heretofore mutually agreed

upon by all parties to this proceeding and placed in evidence in the record herein shall be binding only to the extent where not superseded by future practices mutually agreed to by all interested parties. If and when said practices are revised a copy of such changes shall be forwarded to this Commission for purposes of record. These practices shall not in any manner supersede the requirements for prevention or mitigation of inductive interference between electric power and communication circuits, as contained in General Order No. 52 of this Commission.

The effective date of this Order shall be the date hereof.

The foregoing Opinion and Order is hereby approved and ordered filed as the Opinion and Order of the Railroad Commission of the State of California.

Dated at San Francisco, California, this 4th day of April, 1932.

Al Seamy
Leon Williams
W. J. Lin
W. B. Harris
Fred G. Stewart
 Commissioners.

EXHIBIT "A"

21.8 Permanently Grounded means connected to earth in such a manner that no current which can flow in the ground wire will cause a harmful voltage to exist between the grounded conductors and facilities and adjacent exposed conducting surfaces which are in good contact with the earth, or with adjacent surfaces of the earth itself, under the most severe conditions which are liable to arise in practice.

For all circuits, other than a common primary and secondary grounded neutral distribution system of 5000 volts or less, if a resistance of less than 25 ohms is not obtained, measurement being made by any approved method, the equivalent of two 1/2-inch corrosion-resisting rods, not less than eight (8) feet in length and continuous throughout, driven to a minimum depth of eight (8) feet at not less than 6-foot centers, will be considered a permanent ground.

Where a common primary and secondary grounded neutral system is installed, the grounding provisions for such systems, as covered in Rule 32.4, shall apply.

32.4 Grounds and Neutrals

A. Neutral Conductors:

Neutral conductors of supply circuits other than distribution systems of five thousand (5000) volts or less with common primary and secondary grounded neutrals, shall be considered as carrying the same voltage as the current-carrying wires. Where a common primary and secondary grounded neutral

32.4 (Cont'd)

distribution system is installed the neutral conductor may be considered as carrying the same voltage as any of its related system conductors, compliance with the special practices and construction requirements being necessary.

On a common primary and secondary grounded neutral distribution system, the following provisions shall apply:

Wherever existing plant permits, cross ties of the neutral conductor shall be made to form a continuous interconnected grid network. From each grid section there shall be two (2) or more separate and continuous metallic return conductors to the source of supply.

If two (2) return conductors only are used, each shall have a minimum area of approximately fifty (50) per cent of the area of the phase conductor of the largest overhead feeder serving the area. (See Table No. 6-A of Rule 49.4-3 for minimum sizes.)

If more than two (2) return conductors are used, the current-carrying capacity of the return system shall be such that a break in any one (1) path shall leave two (2) or more return paths which, combined shall have a minimum area of approximately fifty (50) per cent of the area of the phase conductor of the largest overhead feeder serving the area, thus providing adequate current-carrying capacity for full load current. (See Table No. 6-A of Rule 49.4-3 for minimum sizes.)

The common neutral grid system shall be grounded at intervals not greater than fifteen hundred (1500) feet. On branch circuits extending from a grid, where return loop paths are not available, the common neutral line

32.4-A (Cont'd)

conductor shall be grounded at intervals not greater than eight hundred (800) feet. Each transformer installation on a branch circuit without a loop return shall be so located that there will be one or more metallic water pipe system grounds, each of a resistance not greater than three and one-half (3.5) ohms, on each side of the transformer installation.

32.4-C Independent Grounds:

Independent grounds or independent ground connections, the resistance of which does not exceed twenty-five (25) ohms, shall be provided for the following:

Lightning Arresters.
 Grounded bond wires.
 Low voltage power or lighting circuits other than common primary and secondary grounded neutral circuits.
 The neutral wire of 4 wire, 3 phase systems where the line voltage exceeds 2,500, other than common primary and secondary grounded neutral systems.

32.4-D Grounds on Common Neutral Systems:

Where a common primary and secondary grounded neutral distribution system is used, the resistance of the continuous metallic neutral grid to ground shall conform to the following requirement:

1. The resistance between said grid and ground at any point shall not exceed three and one-half (3.5) ohms at any time.

If, after definite effort has been made, it is found not practicable to meet the above requirement, the following alternate requirement will be accepted:

2. The resistance between any point of said grid

32.4-D (Cont'd)

and the ground connection at the substation shall not exceed one (1.0) ohm, and, furthermore, the resistance of said ground connection at the substation either (a) shall not exceed one (1.0) ohm, or (b), if in excess of one (1.0) ohm, shall be lower than that of any individual ground connection on the grid, and in no case in excess of two (2.0) ohms.

Measurement of resistance by any approved method is recognized. In lieu of measurements of resistance of the neutral conductor under (2) above, approved joints and demonstrable calculations will be accepted.

In common primary and secondary grounded neutral systems, ground electrodes shall conform to the following minimum specifications:

- (a) One-piece corrosion resisting metal rod or pipe (or equivalent in physical and electrical qualities) five-eighths (5/8) inch diameter by eight (8) feet in length and driven to a minimum depth of eight (8) feet below the surface of the ground.
- (b) Water pipe systems: Where ground wires are attached directly to a water pipe system, they shall be connected on the main line side of any water metering equipment.

The driven ground rod, pipe or equivalent shall be located not less than two (2) feet from the surface of the pole. Where two or more are installed, they shall be located at not less than six (6) foot centers. The separation required from the surface of the pole shall not apply to a connection to the water pipe system or to the connection between two or more driven rods or pipes.

32.6 Location of Common Neutral Conductor on Cross Arms, etc.:

1. Where all circuits are in excess of seven hundred fifty (750) volts, the common neutral line conductor may be located in a pin position in the primary space.
2. Where a circuit or circuits of less than seven hundred fifty (750) volts are involved, the common neutral line conductor shall be located in a secondary related pin position. This rule shall not apply where only D.C. feeders, signal and communication or four hundred forty (440) volt A.C., or other non-related power circuits alone are involved.
3. Where circuits of less than and of more than seven hundred fifty (750) volts are involved, the maintenance of a common neutral line conductor in both primary and secondary positions is permissible, provided proper designation of conductor in the primary position is made, and that a metallic connection of a size not smaller than the largest neutral line conductor involved is made at each location requiring a ground and that said connection is installed in accordance with the construction requirements for ground wires on poles.
4. The multi-grounded primary or secondary neutral line conductor, where continuous, may be used as a return loop of the common neutral, provided it:
 - (1) Is of sufficient current-carrying capacity as provided in Rule 49.4-B, and
 - (2) Is maintained in its relative position on the cross arm, and
 - (3) Is grounded throughout in accordance with the requirements for common neutral line conductors. (See Rule 32.4-D.)

32.6 (Cont'd)

5. The common neutral conductor may be installed in the same conduit with related phase conductors, provided that the insulation of the neutral conductor is not less than that required of the phase wires and, further, that it is considered as a phase wire for the entire run between terminals. Where the conduit installation is a permanently grounded metal vertical riser pipe, the reference to insulation of common neutral shall not apply, provided the neutral wire is connected to both ends of the riser pipe and permanently grounded.

49.4 ConductorsA. Material:

Open wire conductors shall be of copper, copper covered steel, aluminum (including A.C.S.R.), galvanized iron or steel or other corrosion-resisting metal not subject to rapid deterioration, except that where a common primary and secondary grounded neutral distribution system of 5000 volts or less is installed, the following provisions shall apply:

- (1) Galvanized iron or steel shall not be used as a conductor.
- (2) Related phase and neutral line conductors shall be of the same material, except that the neutral conductor may be of copper where the phase conductors are of other approved material.
- (3) All conductors and wires connecting the common neutral line conductor to ground shall be of copper.

49.4-B Size:

The minimum size of wires of various materials which shall be used for the several classes of construction and loadings are listed in Table No. 7. These minimum sizes shall obtain in both urban and rural districts. Larger

49.4-B (Cont'd)

sizes of wire than those shown in the table will often be necessary to maintain reasonable sag and at the same time provide the required safety factors of Rule 44, ground clearances of Table No. 1 and wire clearances of Table No. 2.

In common primary and secondary grounded neutral systems the common neutral line conductor shall have a minimum area approximately not less than fifty (50) per cent of the area in circular mills of the largest related primary phase conductor, and in no case shall have less conductivity or mechanical strength than No. 6 A.W.G. copper.

In common primary and secondary grounded neutral systems the size of the common neutral line conductor to be used with related phase conductors shall be not less than those set forth in the following table:

TABLE NO. 6-1

MINIMUM SIZES OF COMMON NEUTRAL LINE CONDUCTORS

<u>Size of Phase Conductor</u>	<u>Minimum Size of Neutral Conductor</u>
500,000 C.M.	4/0
350,000 "	3/0
250,000 "	2/0
4/0	1/0
3/0	1
2/0	2
1/0	3
1	4
2	6
4	6
6	6

This table is based upon the requirement that the common neutral line conductor shall have a minimum area of approximately fifty (50) per cent of the area of the largest related phase conductor and that the phase and neutral conductors are of the same material. Where not

49.4-B (Cont'd)

of same material, the copper equivalents of the table shall be considered as meeting the requirements.

The minimum sizes of wire given in Table No. 7 are based upon spans not in excess of one hundred fifty (150) feet. Longer spans, except when specifically designated, may be employed without increasing the size of wire, provided the sags and conductor separations are so increased that the allowable working tensions and conductor clearances specified in this order are not violated.

(Table 7)
(Page 66-G.O. 64-A)

49.4-E Connections:

All electrical connections shall be soldered or of such rigid mechanical design that there will be no material increase in the ohmic resistance of the circuit.

52.4-D Designation of Common Neutral:

In common primary and secondary grounded neutral systems, where the common neutral line conductor is installed in a primary pin position, it shall be designated by an approved non-corrosive metal tag having a minimum diameter of not less than one inch upon which shall be permanently imprinted the letters "CN" not less than five-sixteenths (5/16) inch in height. Said tag shall be attached securely to and maintained on the common neutral conductor at each pin position of line arm and buck arm at a distance not more than twelve (12) inches from the face of the cross arm on the climbing side of each pole and so installed as to be clearly visible at all times.

54.6-B2 Ground Wires:

Ground wires may be attached to or run on the surfaces

54.6-B2 (Cont'd)

of poles, provided they are protected throughout their length by suitable protective covering. That portion of the ground conductor not within an eight (8) foot vertical distance from the nearest conductor supported on the pole or structure, or not within a six (6) foot radial distance from a conductor passing but not attached thereto, requires no protective covering, provided the line is located in sparsely settled rural areas and the ground wire is of mechanical strength at least equal to that of No. 4 stranded hard drawn copper wire.

Contact between the ground wire and cross arm braces, guy fastenings or other exposed metal parts is permitted only where it is intended that these elements be grounded and where a positive electrical contact is made between them and the ground wire. Where this latter provision is exercised, no circuit within a vertical distance of three (3) feet below or eight (8) feet above such grounded braces, fastenings or metal parts shall be worked on while any of the circuits involved are energized. (See App. G, Fig. 34.)

Incidental pole wiring connected to the common neutral conductor may be stapled to the underside of cross arms, provided the installation is such as to offer the least possibility of contact to workmen.

57.8 Bonding and Grounding:
(2nd paragraph)

In common primary and secondary grounded neutral systems, the size of the grounding wire from the common neutral line conductor to a point not more than one (1) foot above the ground line at the base of the pole shall be not less than No. 4 A.W.G. copper. It shall be continuous,

57.8 (Cont'd)

without splices throughout its length, and shall be attached directly to the common neutral line conductor. The horizontal portion of the grounding conductor from base of pole to the individual ground electrode shall be installed not less than one (1) foot below the surface of the ground and shall have not less conductivity and mechanical strength than No. 1 M.H.D. stranded copper.

58.4-C Grounds:

Transformer ground connections other than those occurring on a common primary and secondary grounded neutral system shall have a conductivity not less than that of No. 6 A.W.G. copper wire and shall be provided at one of the following locations:

At the transformer pole.

At a pole adjacent to the transformer pole.

At load end of each service supplied from the transformer, separate from the usual house ground, except that where three or more services are supplied from one transformer or bank of transformers, grounds at the two services nearest the transformer pole and one ground at services at approximately five hundred (500) foot intervals will suffice.

Where a common primary and secondary grounded neutral system is used, the grounding wire shall conform to the requirements of Rule 57.8 for such systems and, furthermore, each transformer installation on a branch circuit without a loop return shall be so located that there will be one or more metallic water pipe system grounds of a resistance not greater than three and one-half (3.5) ohms on each side of the transformer installation.

A transformer installation located on a grid section requires no independent ground provided that there is a

58.4-C (Cont'd)

ground connection to the common neutral line conductor, either on the transformer pole or on an adjacent pole, having a resistance not in excess of three and one-half (3.5) ohms.