

ORIGINAL

Decision No. 70489

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

In the Matter of the Application of)
PACIFIC GAS AND ELECTRIC COMPANY for)
an order amending General Order No. 95)
so as to permit the use of 12/20.8 kv)
four-wire wye common neutral overhead)
electric distribution lines.)

Application No. 47540
(Filed April 30, 1965)

(Electric)

F. T. Searls, John C. Morrissey and Ross Workman, for applicant.
Brundidge & Hackler, by Daniel Feins, assisted by M. A. Walters, for IBEW Local Unions; California Water Service Company, by C. G. Ferguson; California Interstate Telephone Company, by Harold E. Throp, interested parties.
N. R. Johnson, for the Commission staff.

O P I N I O N

Applicant seeks amendment of General Order No. 95 in order to permit the use of "12/20.8 kv four-wire wye common neutral overhead electric distribution lines." After due notice, public hearing in the matter was held before Examiner Emerson on August 26 and 27, 1965. The matter is submitted and is ready for decision.

While the specific rule changes proposed are somewhat complex because of their interrelationships, applicant's proposed changes basically involve four propositions, viz.:

- a. Reductions of certain existing minimum conductor clearances,
- b. Reductions in existing minimum strength and conductor conductivity requirements,
- c. The use of a grounded neutral conductor common to high-voltage (12/20.8 kv) and low-voltage (120/240 volts) circuits, and
- d. A pole configuration wherein a single high voltage conductor would be carried at the pole-top position with a transformer connected thereto and with its return conductor connected to a common neutral carried at the low-voltage position on the pole.

Until 1932, the use of common-neutral systems in California was prohibited by this Commission's "Rules for Overhead Line Construction." In that year, following a number of years of study, the rules of the then General Order No. 64-A were modified to permit use of a common neutral for primary line voltages not exceeding 5,000 volts and common-neutral systems were constructed in a number of areas in the State. General Order No. 64-A was superseded by General Order No. 95 in 1942. This latter order, still effective, continues, in the several parts of Rule 59 thereof, the original provisions governing the use of common-neutral systems, including the 5,000-volt limitation.

Primarily because of electric load growth and increased load densities, common-neutral systems have virtually disappeared in California; for it has become economically infeasible to meet such increased loads at the 5,000-volt limitation prescribed by the present rule. Other states do not appear to have such voltage limitation on common-neutral systems and common-neutral systems are commonly being used in various parts of the country at voltages as high as 20/34.5 kv.

Applicant undertook a study to determine the most economical distribution design for supplying suburban areas at high load densities. With much of its present distribution being three-wire 12 kv, its study, among other things, revealed that some economic advantage would result if the existing 12 kv distribution were to be converted to 12/20.8 kv (four-wire wye). By such conversion, existing distribution circuits would gain greater capacity and applicant's existing 12 kv transformers could be retained in service for use on the higher voltage lines. In addition, its present overhead distribution circuits, if converted to 12/20.8 kv could be more economically tied into, or extended to form, underground distribution circuits in suburban areas.

The rules embodied in General Order No. 95, while contributing materially to the high standard of electric service rendered to the public in California, have their greatest impact on the safety aspects of line construction and maintenance. To a great degree they are designed to provide as much protection (to linemen and other workmen who must construct, repair, operate and generally maintain overhead lines) as is reasonably attainable, having in mind that the demands for continuity of electric service to the public require that literally hundreds of linemen daily perform their work on, or while exposed to the hazards of, energized conductors and equipment. Improvements in work methods, protective devices, materials of construction, tools, insulation, and pole-line hardware and appurtenances directly affect progress in the "state of the art" of electric distribution and generally tend to lessen the hazards to which workmen are exposed in their daily work.

Conductor separations, the prohibition or limitation of physical obstructions in climbing and working spaces, and the absence of grounded surfaces at the working levels on poles all contribute towards the safety of the workmen. All of these may be loosely classified as "clearances" and General Order No. 95 is replete with requirements for the same, generally specified as minimums. In nearly all instances, the rules of the General Order specify irreducible minimums, determined after many years of professional and expert analyses of construction practices, work methods and nonfatal as well as fatal accidents. In some instances, the utilities in California have established, by their own standards, construction practices which provide greater than the minimum "clearances" specified by this Commission. A vigorous program of inspection by the Commission has, over a period of many years, contributed immeasurably to the elimination of hazards and dangerous

practices and has assured adherence to the rules of General Order No. 95; all to the ultimate advantage of the workman and to the public generally.

Three main safety problems are brought to the fore by applicant's proposal in this proceeding. They have to do with the hazards of the physical placement of the common-neutral conductor; the possible electrical elevation of the common-neutral conductor above ground potential and the work methods when connecting, disconnecting or replacing transformers and other equipment. These generate the real concern of workmen in this State and the fear that an increase in the present inherent hazards will result if applicant's proposals are authorized.

With respect to its physical placement, it is noted that elsewhere in the nation, the common-neutral line conductor may be carried in any one of a number of positions on the pole. It is not unusual to find it attached to the surface of pole between cross-arm quarter braces. It may also be carried at either or both secondary and primary levels without special identification. In many places it is uninsulated and uncovered throughout its length. In some places it is carried at reduced vertical separation from other primary conductors above. As we understand the testimony in this proceeding, workmen who object to common-neutral usage anticipate similar placement and treatment in California and fear its consequences. None of these conditions may prevail in California, however, because of our rules which generally provide that obstructions must be kept out of climbing and working spaces, that line conductors must be kept appropriate distances from center-line and surface of pole and that exposure of workmen to grounded objects on poles must be kept to an irreducible minimum. This Commission sees no reason to depart from its long-standing rules to such effect.

With respect to the "voltage" of a common-neutral conductor, existing rules in this State provide that such conductor may be considered as carrying the same voltage as any of its related system conductors. Thus, it either may be considered as carrying 20.8 kv or as carrying 240 volts in a common-neutral connected four-wire wye circuit of 12/20.8 kv common to a 120/240 volt circuit. Like any neutral line conductor of any circuit, it is always considered by the workmen as carrying an electrical potential above that of the earth to which it may be "grounded". Its "grounding" is only for purposes of circuit stabilization and circuit protection (such as fault relaying); thus it, and never the earth, constitutes the circuit's return conductor. It is as much a part of an electrical circuit as any of its related phase conductors. If special precautions are not taken, therefore, the common-neutral conductor may in fact carry a dangerous potential with respect to earth or other "grounded" objects. Rule 59 of General Order No. 95 specifies these special precautions. Basically, this rule accomplishes three things. First, it ensures that the physical size and conductivity of the common-neutral conductor will be reasonably adequate to carry fault as well as normal full-load currents. Second, it ensures that the potential of the common-neutral conductor will be as nearly that of earth as it is practicable or feasible to obtain in the present state of the art. Third, it controls the location of and identifies the location of the common-neutral conductor.

In theory, at least, with the special practices specified in Rule 59 a common-neutral could be related to almost any primary distribution voltage without creating undue hazards to workmen or to the public. Practically, however, a fundamental limitation must be faced respecting the ability to obtain a "zero potential" common neutral. Because the relatively thin mantle of soil into which ground

rods are driven is unconsolidated material, composed of variable and complex combinations of chemicals, minerals, air, organic material, cellular structures and water content, it offers a widely varying resistance to the flow of electric current. A "good" electrical ground is thus not only sometimes difficult to obtain but sometimes impossible. With identical electrical equipment, a "ground" of less than one ohm might be easily obtainable in marshy land, whereas in soil predominantly rocky or composed of desert sand the resistance might be several thousand ohms. Because of such conditions there are some areas in California that are wholly unsuitable for common-neutral distribution systems. In the main such areas are sparsely settled and there is little, if any, economic or aesthetic need therein for common-neutral distribution systems. Recognizing the variability of ground resistance and usually obtainable grounds, Rule 59 specifies special practices which, among other things, provide for a grid-work of neutral conductor return paths, multiplicity of ground connections and the use of water system piping as a means of gaining greater area contact between grounding electrodes and earth. At the time Rule 59 was promulgated metallic-pipe water systems were universally used. In recent years, however, water systems have taken to the use of non-metallic mains to such an extent that today virtually no new water system uses metallic distribution mains. There has thus disappeared from the scene a once valued and oftentimes widespread system of grounding electrodes to which electric utilities could connect their neutral conductors. In view of the foregoing, it seems readily apparent that Rule 59 needs such revision as will bring it into the focus of present-day conditions and permit of its application to the higher voltages of today's distribution systems. Applicant's proposal respecting grounding would lessen existing requirements by

substituting grounds of undetermined resistance values for the 3-1/2 ohm ground resistances specified in Rule 59.4-C. Such proposal is unacceptable. With the increased voltages proposed, the grounding requirements should be strengthened rather than weakened.

With respect to the third safety problem, that of work methods to be followed in connecting or disconnecting transformers on common-neutral systems, it might suffice to point out that General Order No. 95 is basically a set of rules governing the design of overhead lines and is not intended to govern work methods;^{1/} yet the safety problem presented is one which will become more prevalent as common-neutral construction becomes more widespread and it thus deserves somewhat greater than ordinary emphasis. On a common-neutral system the least hazardous method of connecting a transformer to energized lines is similar to that which is followed on ordinary lines when transformers on different poles are interconnected through their secondaries (banked secondaries). Safety to the customer and to the lineman demands in connecting a transformer: that first, the common-neutral be connected to the secondary neutral-tap terminal; that second, the jumper from the secondary neutral-tap terminal to the primary neutral terminal be connected; that third, the secondary hot legs be connected, and that lastly, the primary hot leg be connected. In disconnecting a transformer: first, disconnect the primary hot leg; second, disconnect the jumper from the primary neutral terminal to the secondary neutral-tap terminal; third, disconnect the secondary hot legs; lastly, disconnect the common-neutral from the secondary neutral-tap terminal. When two transformers have their secondaries banked, the

^{1/} Work methods traditionally have been left to the "operating rules" or "safety rules" of the individual utility and oriented to that utility's particular construction standards and operating practices.

least hazardous method of disconnecting one transformer is: first, disconnect the secondary hot legs; second, disconnect the primary hot leg; third, remove the jumper between the primary neutral terminal and the secondary neutral-tap terminal; lastly, disconnect the common-neutral from the secondary neutral-tap terminal. Utility operating and safety rules related to common-neutral systems should clearly and uniformly specify these procedures and linemen should be trained to follow them. No transformer shall have its primary and secondary windings interconnected internally.

Existing rules require that on a pole which carries neutrals at both primary and secondary levels, the connecting conductor between the two shall be equal in size to the larger of the two neutrals. Applicant proposes to reduce this conductor size to that of the smaller neutral. While applicant's desire for economy of construction may be laudable, this proposal borders on "penny-pinching" at the expense of safety. No such reduction will be authorized.

Existing rules provide (Rule 59.3-D) that on common-neutral systems there shall be two or more separate and continuous metallic return conductors from each grid section to the source of supply (the substation). They also provide that if only two return conductors are used, each shall have a minimum area of approximately 50 percent of the area of the primary phase conductor of the largest overhead feeder serving the area, and that if more than two return conductors are used, the current carrying capacity of the return system shall be such that a break in any one path shall leave two or more return paths which, combined, shall have a minimum area of approximately 50 percent of the area of the primary phase conductor of the largest overhead feeder serving the area, thus providing

adequate current carrying capacity for full-load currents. Applicant proposes to eliminate these requirements. Applicant presented no evidence of sufficient weight to warrant any modification of these requirements.

Applicant proposes to use pole-top configurations, on new construction, consisting of a single conductor on a pole-top pin for single-phase primary and a single conductor on a pole-top pin plus two additional conductors installed on post-type insulators below the pole top with the two additional conductors in a vertical plane 18 inches from center line of pole for three-phase primaries. Its illustrations of such configurations are shown on Exhibit F attached to the application. In essence, applicant seeks approval of such illustration. Neither approval nor disapproval of this illustration will be given herein for it is fundamental that the written rules in every instance have precedence over any pictorial illustrations thereof. It is noted, also, that applicant's illustration depicts the use of a large metallic low-voltage rack which is peculiar to its system (having been authorized as a deviation from the low-voltage rack rules), is not authorized for general use in California, and is in fact viewed by Commission engineers as being a departure from accepted good practice. It should, therefore, be limited in its application.

In this proceeding, applicant's engineering witness referred to the "nominal" voltage of the circuits under discussion. It seems necessary, therefore, to emphasize the point that by Rule 23.2, "Voltage" means the highest effective voltage between any two conductors of the circuit concerned. Thus, a circuit energized at 12.1 kv is not a 12.0 kv circuit, nor is one energized at 21.1 kv a 21.0 kv circuit. Further, Rule 14, respecting the

Limiting conditions of maximum and minimum values must be considered. In view of the prospective conversion of existing circuits to higher voltages, the provisions of Rule 52.7 (hardware separations) and Rule 53.4 pertaining to bond wire separations as means of preventing or mitigating radio interference problems which commonly accompany or follow such conversion should be well noted.

In view of the evidence and in the light of the foregoing discussion of various of its elements, the Commission finds:

1. The public interest, including safety to workmen and the public generally, will not be adversely affected by the use of common-neutral systems up to but not above a circuit voltage of 21,000 volts.

2. It is reasonable to modify the existing rules of General Order No. 95 to provide for the construction and operation of such common-neutral systems in California.

The Commission concludes that the application herein should be granted to the extent set forth in the following order and that in all other respects said application should be denied.

O R D E R

IT IS ORDERED that this Commission's General Order No. 95, "Rules for Overhead Electric Line Construction", be and it is hereby modified to the extent set forth in Appendix A attached to this order, said modifications to become effective on the effective date of this order.

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

The effective date of this order shall be twenty days after the date hereof.

Dated at San Francisco, California, this 29th day of MARCH, 1966.

Fredrick B. Holhoff
President
George T. Trover
Augustor
William W. Bennett
Commissioners

APPENDIX A

The rules of General Order No. 95 are modified, amended or added to as set forth below:

1. Rule 20.7

This rule is amended to read as follows:

"COMMON NEUTRAL SYSTEMS mean those electrical supply distribution systems wherein the same specially grounded conductor is utilized as a neutral conductor of primary circuits of less than 21,000 volts and secondary circuits of 0-750 volts supplied therefrom."

2. Rule 32.2-A

This rule is amended to read as follows:

"A. SUPPLY CIRCUITS OF 750-21,000 VOLTS

Supply circuits of 750-21,000 volts should not be above supply circuits in excess of 21,000 volts."

3. Rule 32.4-A1

The first sentence of this rule is amended to read as follows:

"(1) 750-7500 VOLTS AND MORE THAN 21,000 VOLTS: Supply circuits of 750-7500 volts shall not be carried on the same crossarm with circuits of more than 21,000 volts unless the higher voltage circuit is not energized when men are working at this level."

4. Rule 32.4-A2

This rule is amended to read as follows:

"(2) 0-750 VOLTS AND MORE THAN 7500 VOLTS: Supply circuits of 0-750 volts shall not be carried on the same crossarm with circuits of more than 7500 volts, except that, on transformer structures, bus conductors of 0-750 volts and bus conductors of 7500-21,000 volts may be supported on opposite ends of the same bus-supporting timbers provided the horizontal separation between conductors of different classifications supported on the same arm is not less than 36 inches, the bus conductors of 7500-21,000 volts are not extended longitudinally as line conductors, service drops are not supported on arms which support conductors of 7500-21,000 volts, and conductors on related bus arms are not less than 4 feet vertically from such bus timbers."

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5. Rule 32.4-C1

This rule is amended to read as follows:

"(1) 7500-21,000 VOLTS, SAME OWNERSHIP: Supply circuits of 7500-21,000 volts and private communication circuits owned (or leased) and operated and maintained by the same organization may be supported on the same crossarm as provided in Rule 89.2-A1."

6. Rule 33.1

The first sentence of this rule is amended to read as follows:

"Neutral conductors of supply circuits, other than in distribution systems of 21,000 volts or less with common primary and secondary grounded neutrals, shall be considered as carrying the same voltage as the other conductors of the circuit."

7. Rule 37, Table 1.

The heading of Column E of Table 1 is amended to read: "Supply conductors and supply cables, 750-21,000 volts."

The heading of Column F of Table 1 is amended to read: "Supply conductors and supply cables, more than 21,000 volts."

References to "20,000" volts in footnotes n, p, and t are amended to read "21,000 volts."

8. Rule 38, Table 2.

The heading of Column F of Table 2 is amended to read "7,500-21,000 volts."

The heading of Column G is amended to read "21,000-35,000 volts."

References to "20,000" volts in footnotes "r" and "u" are amended to read "21,000" volts.

9. Rule 33.3-B

The first portion of this rule is amended to read as follows:

"Ground connections for equipment of any one of the types listed in Rule 33.3-A shall not be interconnected with ground connections for equipment of any other type listed therein, except:
In common neutral systems the neutral conductors of 0-750 volt supply circuits and of supply circuits of 750-21,000 volts may be interconnected and grounded in accordance with the provisions of Rule 59; and"

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10. Rule 51.6-A

Beginning with the third paragraph of this rule, the rule is amended to read as follows:

"The provisions of this Rule, 51.6-A, shall not apply to the marking of poles at the levels of supply circuits of more than 21,000 volts in rural districts.

See Rule 65 for the marking of towers."

11. Rule 52.4-B2c

This rule is amended to read as follows:

"c) Supporting Conductors of 7500-21,000 Volts at Certain Locations: At all crossings over public thoroughfares and at locations adjacent to structures such as water tanks, windmills and buildings, adjacent to wells, and at similar locations, crossarms supporting conductors of 7500-21,000 volts shall be marked as high voltage."

12. Rule 52.4B2e

This rule is amended to read as follows:

"e) Supporting Conductors of 7500-21,000 Volts on the Same Structure With Conductors of 750 Volts or Less: Where, on the same structures in rural districts, crossarms supporting conductors of 7500-21,000 volts are above conductors of 750 volts or less, the crossarm supporting conductors of 7500-21,000 volts next above the conductors of 750 volts or less shall be marked as high voltage. All crossarms supporting conductors of 7500-21,000 volts below conductors of 750 volts or less supported on the same structure shall be marked as high voltage."

13. Rule 52.4-B3

The first paragraph of this rule is amended to read as follows:

"(3) ON GUARDED METAL POLES: On latticed metal poles which are guarded with barriers as required in Rule 51.6-B, the following crossarms shall be marked as high voltage:
Crossarms supporting conductors of 750-7500 volts;
Crossarms supporting conductors of 7500-21,000 volts next above the level of conductors of 7500 volts or less;
Crossarms supporting conductors of 7500-21,000 volts below the level of conductors of 7500 volts or less; and
Crossarms supporting any conductor of more than 7500 volts within 15 feet of walls, fire escapes, exits, windows and similar objects."

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14. Rule 54.4-A1

The first sentence of this rule is amended to read:

"(1) ACROSS ARID OR MOUNTAINOUS AREAS: Across arid or mountainous areas supply circuits carrying 21,000-30,000 volts, inclusive, may have a clearance of less than 30 feet (Table 1, Case 4, Column F) but not less than 25 feet above ground subject to a reduction of not more than 10 per cent because of temperature and loading as specified in Rule 43."

15. Rule 54.4-A2

The title of this rule is amended to read:

"(2) IN RURAL DISTRICTS, CONDUCTORS OF 750-21,000 VOLTS:"

16. Rule 54.4-C1b

The first sentence of this rule is amended to read:

"b) Conductors of 7500-21,000 Volts: The 4-foot vertical clearance between conductors of 7500-21,000 volts, as specified in Table 2, Case 11, Column F, may be reduced to not less than 3 feet, provided all of the following conditions are met:"

17. Rule 54.4-C2a

The asterisked footnote in this rule is amended to read as follows:

"* Voltage classifications for this purpose are:
0-750 volts,
750-7500 volts,
7500-21,000 volts, and
21,000 volts and above."

18. Rule 54.4-C4c

The figures "750-20,000 volts" in this rule are changed to read "750-21,000 volts".

19. Rule 54.4-C6

The tabular values set forth in this rule are amended to read as follows:

| <u>"Voltage of Lead wires</u> | <u>Minimum distance above other conductor level</u> |
|-----------------------------------|---|
| 0-750 | 12 inches |
| 750-7500 | 18 inches |
| 7500-21,000 | 24 inches |
| 21,000-35,000 | 36 inches" |

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20. Rule 54.4-D2

The figures "7500-20,000 volts" in the second paragraph of this rule are amended to read "7500-21,000 volts".

21. Rule 54.4-D8b

The first paragraph of this rule is amended to read as follows:

"b) More than 7500 Volts: A single conductor of a circuit of more than 7500 volts may be attached directly to the top of a pole or to a crossarm at the top of a pole at a distance less than as specified in Table 1, Case 8, provided no apparatus carried on the pole is connected to the circuit so arranged except lightning arresters, a pole-top switch, or a transformer. Where a transformer is connected to a circuit so arranged, a vertical clearance of not less than 30 inches shall be maintained between the primary conductor directly above and the unenergized metal parts of the transformer, as specified in Rule 58.3-B3e."

22. Rule 54.4-H2

The first paragraph of this rule is amended to read as follows:

"(2) ATTACHED CONDUCTORS: Unprotected conductors not exceeding 21,000 volts may be supported by attachments to buildings, bridges and other structures. To conductors of 0-750 volts so supported, the clearances of Table 1, Case 7, Column B, C and D shall apply. To conductors of 750-21,000 volts so supported a minimum horizontal clearance of 8 feet shall apply."

23. Rule 54.4-I

The first sentence of the second paragraph of this rule is amended to read as follows:

"Conductors of 0-21,000 volts, passing under or through bridges, viaducts or similar structures, may be attached thereto in accordance with the provision of Rule 54.4-E2."

24. Rule 54.6-A

The tabular values in this rule are amended to read as follows:

| <u>Highest voltage classification</u> <u>of conductors concerned</u> | <u>Minimum radial distance</u> <u>between conductors</u> |
|---|---|
| 0-5000 volts | 11-1/2 inches |
| 5000-7500 volts | 17-1/2 inches |
| 7500-21,000 volts | 24 inches |
| 21,000 volts and above | 36 inches" |

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25. Rule 54.6-F

The fourth paragraph of this rule is amended by replacing the phrase "(750-20,000 volts in vertical configuration on non-climbable poles)," with the phrase "(750-21,000 volts in vertical configuration on non-climbable poles),"

26. Rule 54.7-A4

The first sentence of the third paragraph of this rule is amended to read as follows:

"Pin-type insulators which support line conductors of 21,000 volts or less may extend not more than one-half of their diameter into the climbing space."

27. Rule 54.9-E1

The first sentence of this rule is amended to read as follows:

"(1) WITH GUARD ARM BELOW CONDUCTORS OF 750-21,000 VOLTS: The vertical clearance between the top conductor in a rack group and conductors of 750-21,000 volts at the next conductor level above, may be less than 6 feet but shall be not less than 4 feet."

28. Rule 54.9-E4

The figures "7500-20,000 volts" in this rule are amended to read "750-21,000 volts".

29. Rule 56.4-E

This rule is amended to read as follows:

"Where passing guys are less than 15 inches from surface of pole and less than 8 feet below supply conductors of less than 21,000 volts supported on the same pole, such guys shall be sectionalized, in addition to the normal sectionalization required by Rule 56.6, by means of insulators in accordance with Rule 56.6-A as though attached to the pole or structure."

30. Rules 56.6-A, 56.6-B, 56.6-D, 56.6-E.

In these four rules, each time the figures "20,000" appear said figures are amended to read "21,000".

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31. Rule 58.3-B3 e (New Rule)

The general order is amended by adding thereto the following new section to Rule 58.3-B3:

"e) From 7500-21,000 Volt Conductors Above: The clearance between unenergized metal parts of transformers and 7500-21,000 volt conductors above shall be not less than 18 inches vertically or 18 inches horizontally except that the vertical clearance shall be not less than 30 inches from a conductor at the top of pole as in Rule 54.4-D8b."

32. Rule 58.3-B4b

The last limiting condition of this rule is amended to read as follows:

"The vertical clearance of 0-750 volt conductors below the lowest point of the transformer primary leads is not less than
18 inches for primary leads of 750-7500 volts,
24 inches for primary leads of 7500-21,000 volts,
and
36 inches for primary leads of 21,000-35,000 volts."

33. Rule 58.3-E (New Rule)

The general order is amended by adding thereto the following new section to Rule 58.3:

"E. CONNECTIONS BETWEEN WINDINGS
Any metallic connection between the primary and secondary windings of a distribution transformer (as in common neutral systems) shall be made externally and not within the transformer case."

34. Rule 58.4-B3b

This rule is amended to read as follows:

"b) From Conductors in Excess of 750 Volts Below: The vertical clearance of capacitor and regulator cases and their hangars from the level of conductors in excess of 750 volts below shall not be less than
12 inches for conductors of 750-7500 volts,
18 inches for conductors of 7500-21,000 volts,
24 inches for conductors of 21,000-35,000 volts."

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35. Rule 59.2

This rule is amended to read as follows:

"The following rules cover certain special details for common neutral systems where the neutral conductor is common to primary circuits of less than 21,000 volts and secondary circuits of 0-750 volts supplied therefrom. These rules are supplemental to the rules given for supply lines in general and to other detailed construction requirements for supply lines."

36. Rule 59.3-B, Table 14

Table 14 in Rule 59.3-B is amended by inserting therein a primary conductor size of 715,500 circular mils and a related neutral conductor size of 350,000 circular mils.

37. Rule 59.3-D

This rule is amended to read as follows:

"D. NEUTRAL CONDUCTORS

The arrangement and continuity of common neutral conductors shall conform to the following requirements:

Cross ties of the neutral conductor shall be made to form a continuous interconnected grid network and there shall be not less than two separate and continuous metallic return conductors from the grid network to the substation constituting the source of supply thereto.

If two return conductors only are used, each shall have a minimum conductivity of approximately 50 per cent of the conductivity of the primary phase conductor of the largest overhead feeder serving the area (see Table 14 of Rule 59.3-B for minimum sizes).

If more than two return conductors are used the current-carrying capacity of the return system shall be such that a break in any one path shall leave two or more return paths which, combined, shall have a minimum conductivity of approximately 50 per cent of the conductivity of the primary phase conductor of the largest overhead feeder serving the area thus providing adequate current-carrying capacity for full load current (see Table 14 of Rule 59.3-B for minimum sizes).

Primary neutral conductors or secondary neutral conductors, where continuous, may be used as a return loop from a common neutral provided they are of sufficient current-carrying capacity as specified in Rule 59.3-B and provided that they are grounded throughout in accordance with the requirements for common neutral line conductors as specified in Rule 59.4-B. Primary or secondary neutral line conductors so used shall be carried in their normal primary or secondary positions, respectively."

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38. Rule 59.4-A2

This rule is amended to read as follows, with sections a) and b) thereof thus being deleted:

"(2) GROUND ELECTRODES: Ground electrodes on common neutral systems shall be one-piece corrosion-resisting metal rods or pipes (or equivalent in physical and electrical properties) not less than 5/8-inch in diameter by 8 feet in length and driven to a minimum depth of 8 feet below the surface of the ground. Pole-butt plates or wrappings shall not be used either in lieu of the aforesaid rods or pipes or as electrodes supplementary thereto.

The driven ground rod, pipe or equivalent shall be located not less than 2 feet from the surface of the pole. Where two or more such rods are installed, they shall be located at not less than 6-foot centers and the separation required from the surface of the pole shall not be held to apply to the connection between rods."

39. Rules 59.4-A2a and 59.4-A2b are deleted.

40. Rule 59.4-B1

This rule is amended to read as follows:

"(1) LOCATION: The common neutral grid system shall be grounded at intervals not greater than 1000 feet. On branch circuits extending from a grid, where return loop paths are not available, the common neutral line conductor shall be grounded at intervals not greater than 500 feet. Each transformer installation on a branch circuit without a loop return shall be so located that there will be not less than one ground, of a resistance not greater than 3-1/2 ohms, on each side of the transformer installation."

41. Rule 59.4-C

The second paragraph of this rule is amended to read as follows:

"On common neutral systems, each transformer installation on a branch circuit without a loop return shall be so located that there will be not less than one ground, of a resistance not greater than 3-1/2 ohms on each side of the transformer installation."

42. Rule 86.4-E

The figure "20,000 volts" in this rule is amended to read "21,000 volts".

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- 43. Rule 86.6-A
- Rule 86.6-B
- Rule 86.6-C
- Rule 86.6-D

In each of these rules, the figures "20,000" are amended to read "21,000".

- 44. Rule 86.7-A1
- Rule 86.7-A2

In each of these rules, the figures "20,000" are amended to read "21,000".

- 45. Rule 89.2-A

In this rule, the figures "20,000" are amended to read "21,000".

- 46.. Rule 89.3

In this rule, the figures "750-20,000" are amended to read "750-21,000".

- 47. Rule 92.1-A

The last line of this rule is amended to read:

"Circuits of 0-21,000 volts or communication
circuits4 feet"

- 48. Appendix G

Wherever the figures "20,000" appear in the illustrations set forth in Appendix G, said figures are amended to read "21,000".

- END OF AMENDMENTS -