2026
ELECTRIC DISTRIBUTION DESIGN MANUAL
FIELD MAINTENANCE ONLY

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SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL FIELD MAINTENANCE ONLY

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UNDERGROUND LAYOUT SYSTEMS

FMO
DM5201

DM5223 FIELD MAINTENANCE ONLY

ALL VERSIONS LISTED IN FMO ARE SUPERSEDED BY THEIR CURRENT VERSION FOUND INSIDE THE ELECTRIC DISTRIBUTION DESIGN MANUAL.

REVISION HISTORY:

02/21/2025: DM5223 MOVED TO FMO

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SCOPE

This design standard provides the residential secondary and service system optimum array tables used in conjunction with the General Design Criteria provided in Design Manual 5222. These tables represent an economic analysis of secondary and service system design alternatives, on a cost per lot basis, for approximately 9600 different array possibilities.

PURPOSE

The optimum array tables shall be used for residential single-family subdivision design to insure the lowest cost system is installed.

DEFINITIONS

NONE

OPTIMUM ARRAY TABLE APPLICATION

A. The optimum array tables provide the optimum array configuration, transformer size and secondary/service cable selections based on KW demand, secondary distance, and service distance. The instructions for properly applying the optimum array tables are as follows:

1. Determine KW Demand

   Determine the KW demand per lot for the subdivision from the Residential Demand Estimating Criteria, Design Manual 5322.

2. Determining Secondary Distance

   The secondary footage and structure (Transformer Pad or Handhole) placement is dictated by the lot front footage, street width, and meter location. Typically, the structures will be placed at the load center to serve as many meters as possible from one location. This requires the secondary footage to span from one to four lots or the street width. Therefore, the secondary footage is determined by:

   a. Measuring the distance across the number of lots being spanned or the distance across the street

   b. Adding footage to the overall distance for cable tools (Design Manual 5922). The typical secondary footage for a subdivision should be determined by measuring several lot combinations and using the most common footage(s) as a benchmark for optimum array selections.

3. Determining Service Distance

   The service distance for a single-sided array service or double-sided array short service is equal to the service panel setback. The double-sided array long service is equal to the service panel setback plus the distance from the originating structure across the street to the property line. The service panel setback is either an estimated or measured distance from behind the sidewalk at the property line to the service panel location. Additional footage shall be added to this distance from the service cable tails (Design Manual 5922).

4. Selecting Optimum Arrays

   Select the subdivision single-sided and/or double-sided optimum array configuration from the table with the appropriate KW demand, secondary and service lengths. The optimum array selection for the subdivision may be used for each individual array whose secondary and service footage does not differ from the typical by more than ten feet. Otherwise, an individual array selection must be made.

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a. There are a sufficient number of optimum array tables to address most of the system configurations that will be encountered in residential subdivisions. However, when the required system configuration does not permit selection of an optimum array, consult Design Manual 5222, General Design Procedures Paragraph 7.

b. The short service on single and double-sided arrays (Service to the homes on the same side of the street as the transformer) is 2 - #2 and 1 - #4 Al unless a note to the contrary appears below the table.

c. Listed below are the double-sided array, long service, and corresponding short service distances.

d. The arrays are symmetrical about the transformer unless a note to the contrary is shown.

Double–sided array

Long Service	Short Service
150'	50'
140'	50'
130'	50'
120'	40'
110'	40'
100'	30'
90'	30'
80'	20'

5. The subdivision should now be blocked off in groups of lots corresponding to the number of customers that can be served by the selected optimum array(s):

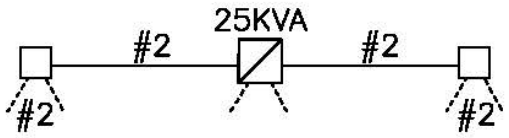
   a. A single-sided and double-sided array combination can be used effectively to serve lots of irregular width or layout (Such as in a cul-de-sac). The combination array must be constructed as shown in Example 3 where the variation can only be used directly off the transformer; not as an extension from any of the handholes.

   b. Additional lots may be served from any handhole in an optimum array provided the number of runs connected in the handhole do not exceed the handhole capacity (Presently 6). However, the voltage drop, flicker, and transformer loading limits must be satisfied based on Design Manuals 5431 and 5621.

EXAMPLES

Select the single-sided optimum array for a subdivision having USA cable an average secondary distance of 120' (55' lot fronts, 6' additional for USA cable tails), average service length of 40' (30' service panel setback, 6' additional for USA cable tails), serving 1200 square foot homes with electric water heating.

1. From the optimum array table on Design Manual 5223.4, the single-sided optimum array for 120' secondary and 40' service serves six customers with a 25 KVA as shown below.



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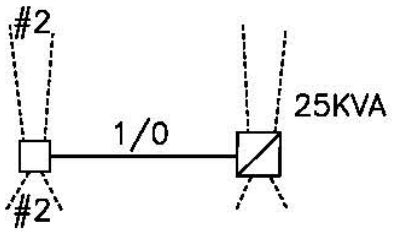
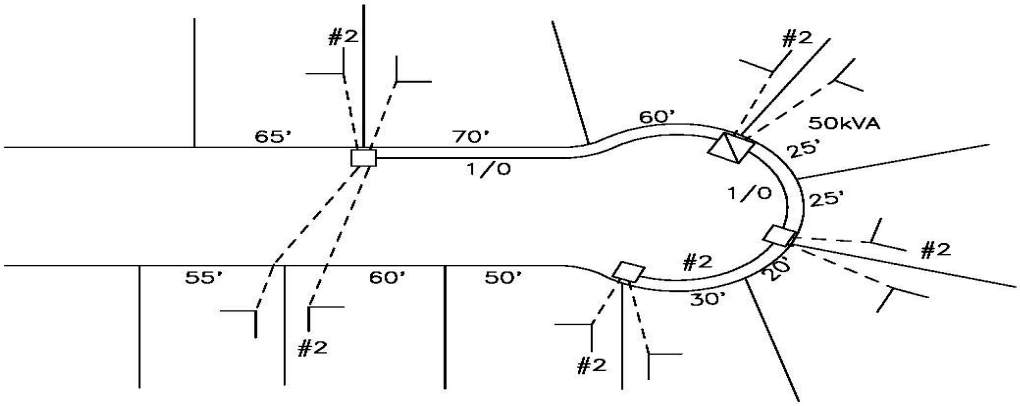
Select the double-sided optimum array for the subdivision described in Example 1 having a 90' long service (50' wide streets).

2. From the optimum array table on Design Manual 5223.4, the double-sided optimum array for this combination serves eight customers with a 25 KVA as shown below.



Select the combination optimum array having 1200 square foot homes with electric water heating (Single-sided and Double-sided) to serve the cul-de-sac shown below. The lot front footages are provided; short-service length is 40', long-service length is 90'.

3. The resulting combination optimum array serves ten customers, 4 double-sided (140' secondary) and six single-sided (60' secondaries). The transformer loading for ten customers is 36 KW. Therefore, a 50 KVA transformer is selected.



REFERENCES

A. Design Manual 5223 – Residential Distribution System Design

B. Design Manual 5712 – Secondary Handhole Elimination

C. Design Manual 5411 – Voltage Drop & Flicker Application Guidelines

D. Study – "Reduced Secondary and Service System Cost Through Optimum Single-Family Residential Design", May 1985

E. Design Manual 5922 – Cable Tail Length Requirements

F. Design Manual 5322 – Residential Demand Estimating

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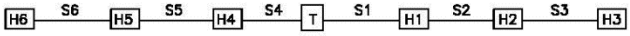

Sq. Ft.: 0–1299 SINGLE–SIDED

3kW Base Load (BL)

Sec Ft	Serv Ft S1–S2–S3	# Cust
	25kVA	
60–70	20–50 1/0–#2–#2	14
80–100	20–50 #2–#2	10
110	20–40 #2–#2	10
110	50 1/0–#2	10
120–130	20–50 1/0–#2	10
140	20–40 1/0–#2	10
140	50 1/0–1/0	10
150	20–50 1/0–1/0	8(S)

5kW Air Conditioning (A/C)

Sec Ft	Serv Ft S1–S2–S3	# Cust
	25kVA	
60	20–40 3/0–1/0–1/0	14
60	50 3/0–1/0–1/0	12(u)
70	20–50 1/0–#2	10
80–140	20–50 #2	6
150	20–40 #2	6
150	50 1/0	6

5kW Electric Water Heater (EWH)

Sec Ft	Serv Ft S1–S2	# Cust
	25kVA	
60–80	20–50 1/0–#2	8(s)
90–100	20–40 1/0–1/0	8(s)
90–100	50 1/0–1/0	8(a)
110	20 #2	6
110	20–50 3/0–1/0	8(s)
120	20–40 #2	6
120	50 3/0–1/0	8(s)
130–150	20–50 #2	6

4kW Electric Heater(EH)

Sec Ft	Serv Ft S1–S2	# Cust
	25kVA	
60–80	20–50 #2–#2	10
90	20–50 1/0–#2	10
100–110	20–50 1/0–1/0	10
120	50 1/0–1/0	10
120	20–40 #2	6
130–150	20–50 #2	6

3kW A/C Option

Sec Ft	Serv Ft S1–S2	# Cust
	25kVA	
60	20–50 #2	10
70	20–30 #2	10
70	40–50 1/0–#2	10
80	20 #2	10
80	30–50 1/0–#2	10
90	20–50 1/0–#2	10
100	20–30 1/0–#2	10
100	40–50 1/0–1/0	10
110	20–40 1/0–1/0	10
110	50 1/0–1/0	8(s)(a)
120	20–30 1/0–1/0	10
120	40 1/0–1/0	10(e)
120	50 1/0–1/0	8(s)(a)
130–150	20–50 #2	6

DOUBLE–SIDED

3kW Base Load (BL)

Sec Ft	Serv Ft S1–S2	# Cust
	25kVA	
60	80–140 #2–#2	16
60	150 1/0–#2	16(a)
70	80 #2–#2	16
70	90–150 1/0–#2	16(a)
80	80–130 1/0–#2	16(a)
80	140–150 1/0–1/0	16(a)
90	80–90 1/0–#2	16
90	100–150 1/0–1/0	16(a)
100	80–130 1/0–1/0	16(a)
100	140–150 #2	12
110	80–100 1/0–1/0	16(a)
110	110–150 #2	12
120–140	80–150 #2	12
150	80–150 1/0	12

5kW Air Conditioning (A/C)

Sec Ft	Serv Ft S1–S2–S3	# Cust
	75kVA	
60	80 3/0–1/0	16(a)
60	90–120 3/0–1/0	16(a)(a)
60	130–140 3/0–1/0	16(t)(a)
60	150 3/0–3/0	20(e)
70	80–90 3/0–3/0	16(t)
70	100–110 3/0–3/0	20(e)
70	120–140 3/0–3/0	16(a)(a)
70	150 3/0–3/0	16(k)
80	80–110 3/0–3/0	16(t)(a)
80	140 3/0–3/0	16(t)(j)
80	150 350–3/0	20(e)
	50kVA	
80	120–130 1/0	12
90	80–110 1/0	12
90	120–130 1/0	12
90	140–150 1/0	12(f)
100	80 1/0	12
100	90–130 1/0	12(f)
100	140–150 3/0	12(f)
110	80–130 1/0	12(f)
110	140–150 3/0	12(f)
120	80–110 1/0	12(f)
120	120–140 3/0	12(f)
120	150 3/0	12(n)
130	80–90 3/0	12
130	100–130 3/0	12(f)
130	140–150 3/0	12(n)
140	80–90 3/0	12
140	100–130 3/0	12(f)
140	140–150 3/0	12(n)
150	80–90 3/0	12
150	100–130 3/0	12(f)
150	140–150 3/0	12(n)

5kW Electric Water Heater (EWH)

Sec Ft	Serv Ft S1–S2	# Cust
	50kVA	
60	80–150 3/0–1/0	20
70	80–150 3/0–1/0	20(e)
80	80–110 3/0–3/0	20
80	120 3/0–3/0	16(t)
90	80 3/0–3/0	20(e)
	25kVA	
80	130–150 1/0	8
90	90–150 1/0	8
100–110	80–150 1/0	8
120	80–130 1/0	8
120	140–150 1/0	8(c)
130	80–100 1/0	8
130	110–150 1/0	8(c)
140	80–90 1/0	8
140	100–150 1/0	8(c)
150	80–120 1/0	8(c)
150	130–150 3/0	8

4kW Electric Heater(EH)

Sec Ft	Serv Ft S1–S2	# Cust
	50kVA	
60	80–150 1/0–1/0	20
70–80	80–150 3/0–1/0	20
90	80–140 3/0–1/0	20
	25kVA	
90	150 #2	8
100	80–150 #2	8
110	80–130 #2	8
110	140–150 1/0	8
120	80–90 #2	8
120	100–150 1/0	8
130–150	80–150 1/0	8

3kW A/C Option

Sec Ft	Serv Ft S1–S2	# Cust
	50kVA	
60	80–90 1/0–#2	20
60	100–110 1/0–1/0	20
60	120–150 1/0–1/0	20(e)
70	80–100 1/0–1/0	20
70	110–150 1/0–1/0	20(e)
80	80–90 1/0–1/0	20
80	100–140 1/0–1/0	20(e)
80	150 3/0–1/0	20(e)
90	80–120 1/0–1/0	20(e)
90	130–150 3/0–1/0	20(e)
100	80–110 1/0–1/0	20(e)
100	120–140 3/0–1/0	20(e)
100	150 3/0–3/0	20(e)
110	80 1/0–1/0	20(e)
110	120–150 3/0–3/0	20(e)
	25kVA	
110	90–110 1/0	8
120–150	80–150 1/0	8

a)H2=1/0, b)H3=1/0, c)H1=1/0, d)H4=1/0, e)H2–H5=1/0–1/0, f)H1–H4=1/0–1/0, g)H2–H4=1/0–1/0
h)H3–H6=1/0–1/0, i)H3–H5=1/0–1/0, j)H2=3/0, l)H3–H5=3/0–1/0, m)H2–H4=1/0–3/0, n)H1–H4=3/0–3/0
o)H2–H5=3/0–3/0, p)H2–H4=3/0–3/0, q)H1–H2–H4=1/0–1/0–1/0, r)H1=3/0
s)S4=#2, t)S4–1/0, u)S4–S5=1/0–#2, v)S4–S5=1/0–1/0, w)S2–S4=3/0–1/0, x)S4=3/0

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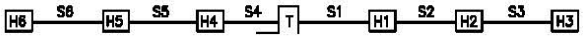

Sq. Ft.: 1300–1999 SINGLE–SIDED

4kW Base Load (BL)

Sec Ft	Serv Ft S1–S2		# Cust
	25kVA		
60–80	20–50	#2–#2	10
90	20–50	1/0–#2	10
100–110	20–50	1/0–1/0	10
120	50	1/0–1/0	10
120	20–40	#2	6
130–150	20–50	#2	6

6kW Air Conditioning (A/C)

Sec Ft	Serv Ft S1–S2		# Cust
	50kVA		
60–70	20–50	1/0–1/0	10
80	20–50	1/0–1/0	10(e)
90	20	3/0–1/0	10
90	30–50	3/0–1/0	10(e)
100	20	3/0–3/0	10
100	30–50	3/0–3/0	10(e)
110	20–50	3/0–3/0	10(e)
120	20–40	3/0–3/0	8(t)
120	50	3/0–3/0	8(a)
	25kVA		
130	20–40	1/0	6
130	50	1/0	6
140–150	20–40	1/0	6
140–150	50	1/0	6(f)

6kW Electric Water Heater (EWH)

Sec Ft	Serv Ft S1–S2–S3		# Cust
	50kVA		
80	20	3/0–1/0–1/0	14
60	30	3/0–1/0–1/0	12(u)
60	40–50	3/0–1/0–1/0	12(u)(B)
70	20–50	3/0–3/0–3/0	12(v)
	25kVA		
80–120	20–50	#2	6
130	20–40	#2	6
130	50	1/0	6
140–150	20–50	1/0	6

5kW Electric Heater(EH)

Sec Ft	Serv Ft S1–S2		# Cust
	25kVA		
60–80	20–50	1/0–#2	8(a)
90–100	20–40	1/0–1/0	8(a)
90–100	50	1/0–1/0	8(a)
110	20	#2	6
110	30–50	3/0–1/0	8(a)
120	20–40	#2	6
120	50	3/0–1/0	8(a)
130–150	20–50	#2	6

4kW A/C Option

Sec Ft	Serv Ft S1–S2		# Cust
	50kVA		
60	40–50	1/0–1/0	8(a)(a)
70	40	1/0–1/0	10
	25kVA		
60	20–30	1/0–1/0	8(a)(a)
70	20–30	3/0–1/0	8(a)
70	40–50	3/0–1/0	8(a)(a)
80	20	3/0–1/0	8(a)
80	30–40	3/0–1/0	8(t)(f)
80	50	1/0	6
90	20–50	1/0	6
100	20–40	1/0	6
100	50	1/0	6(f)
110	20–30	1/0	6
110	40–50	1/0	6(f)
120	20–30	1/0	6
120	40	1/0	6(f)
120	50	3/0	6
130	20	1/0	6
130	30	1/0	6(f)
130	40–50	3/0	6
140	20	1/0	6(f)
140	30–50	3/0	6
150	20	1/0	6(f)
150	30–40	3/0	6
150	50	3/0	6(f)

a)H2=1/0, b)H3=1/0, c)H1=1/0, d)H4=1/0, e)H2–H5=1/0–1/0, f)H1–H4=1/0–1/0, g)H2–H4=1/0–1/0
h)H3–H6=1/0–1/0, i)H3–H5=1/0–1/0, j)H2=3/0, l)H3–H5=3/0–1/0, m)H2–H4=1/0–3/0, n)H1–H4=3/0–3/0
o)H2–H5=3/0–3/0, p)H2–H4=3/0–3/0, q)H1–H2–H4=1/0–1/0–1/0, r)H1=3/0
s)S4–#2, t)S4=1/0, u)S4–S5=1/0–#2, v)S4–S5=1/0–1/0, w)S2–S4=3/0–1/0, x)S4=3/0

DOUBLE–SIDED

4kw Base Load (BL)

Sec Ft	Serv Ft S1–S2		# Cust
	50kVA		
60	80–150	1/0–1/0	20
70–80	80–150	3/0–1/0	20
90	80–140	3/0–1/0	20
	25kVA		
90	150	#2	8
100	80–150	#2	8
110	80–130	#2	8
110	140–150	1/0	8
120	80–90	#2	8
120	100–150	1/0	8
130–150	80–150	1/0	8
120	100–150	1/0	8
130–150	80–150	1/0	8

6kW Air Conditioning (A/C)

Sec Ft	Serv Ft S1–S2		# Cust
	75kVA		
60	80–100	3/0–3/0	16(q)(t)
60	110–150	3/0–3/0	16(g)(t)
70	80–100	1/0	12
70	110–150	350–3/0	16(g)(t)
80	80–90	1/0	12
80	100–130	350–3/0	16(g)(t)
80	140–150	3/0	12(f)
90	80–90	1/0	12
90	100–150	1/0	12(f)
100	80	1/0	12
100	90–130	1/0	12(f)
100	140–150	3/0	12(f)
110	80–130	1/0	12(f)
110	140–150	3/0	12(f)
120	80–110	1/0	12(f)
120	120–140	3/0	12(f)
120	150	3/0	12(n)
130	80–90	3/0	12
130	100–130	3/0	12(f)
130	140–150	3/0	12(n)
140	80–90	3/0	12
140	100–130	3/0	12(f)
140	140–150	3/0	12(n)
150	80–90	3/0	12
150	100–120	3/0	12(f)
150	130–150	3/0	12(n)

6kW Electric Water Heater (EWH)

Sec Ft	Serv Ft S1–S2		# Cust
	75kVA		
60	80110	3/0–3/0	20
60	120–150	3/0–3/0	20(e)
70	80	3/0–3/0	20
70	90–100	3/0–3/0	20(e)
70	110	1/0	12
80	80–100	3/0–3/0	20(e)
80	110	1/0	12
	50kVA		
70	120–150	1/0	12
80	120–140	1/0	12
80	150	1/0	12(e)
80	80–120	1/0	12
80	130–150	1/0	12(f)
90	80–110	1/0	12
100	120–150	1/0	12(f)
110	80	1/0	12
110	90–150	1/0	12(f)
120	80–120	1/0	12(f)
120	130–150	3/0	12
130	80	1/0	12(f)
130	90–140	3/0	12
130	150	3/0	12(f)
140	80–120	3/0	12
140	130–150	3/0	12(f)
150	80–110	3/0	12
150	120–150	3/0	12(f)

5kW Electric Heater(EH)

Sec Ft	Serv Ft S1–S2		# Cust
	50kVA		
60	80–150	3/0–1/0	20
70	80–150	3/0–1/0	20(e)
80	80–110	3/0–3/0	20
80	120	3/0–3/0	16(t)
90	80	3/0–3/0	20(e)
	25kVA		
80	130–150	1/0	8
90	90–150	1/0	8
100–110	80–150	1/0	8
120	80–130	1/0	8
120	140–150	1/0	8(c)
130	80–100	1/0	8
130	110–150	1/0	8(c)
140	80–90	1/0	8
140	100–150	1/0	8(c)
150	80–120	1/0	8(c)
150	130–150	3/0	8

4kW A/C Option

Sec Ft	Serv Ft S1–S2		# Cust
	75kVA		
60	80	3/0–1/0	20
60	90–120	3/0–1/0	20(e)
60	130–140	3/0–3/0	20(e)
60	150	3/0–3/0	20(e)
70	80–120	3/0–1/0	20(e)
70	130	3/0–3/0	20(e)
70	140–150	3/0–3/0	20(e)
80	80–100	3/0–1/0	20(e)
80	110–130	3/0–3/0	20(e)
80	140–150	3/0–3/0	20(a)
90	80–120	3/0–1/0	20(e)
90	140–150	3/0–3/0	20(a)
100	80	3/0–1/0	20(e)
100	90–110	3/0–3/0	20(e)
100	140–150	3/0–3/0	20(a)
	50kVA		
90	130	3/0–3/0	16(t)(w)
100	120	3/0–3/0	16(t)(w)
100	130	3/0–3/0	16(w)
110	80–90	1/0	12(f)
110	100–150	3/0	12(f)
120	80–90	1/0	12(f)
120	100–130	3/0	12(f)
120	140–150	3/0	12(n)
130	80–90	1/0	12(f)
130	100–130	3/0	12(f)
130	140–150	3/0	12(n)
140	80–120	3/0	12(f)
140	130–150	3/0	12(n)
150	80–120	3/0	12(f)

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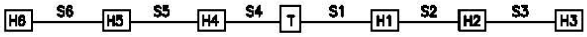
B	FORMATTING	JIK	-	-	02/21/2020	E					
A	ORIGINAL ISSUE	-	CVN	RDG	01/01/1987	D					

X Indicates Latest Revision | Completely Revised | New Page | Information Removed

SINGLE FAMILY RESIDENTIAL SECONDARY SYSTEMS



Sq. Ft.: 2000–2999 SINGLE–SIDED

4.5kW Base Load (BL)

Sec Ft	Serv Ft	S1–S2	# Cust
	25kVA		
	20–50	#2	10
70–80	20–50	1/0–#2	10
90–100	20–50	1/0–1/0	10
	20–50	1/0–1/0	8(a)(a)
120–150	20–50	#2	6
60			
110			

7kW Air Conditioning (A/C)

Sec Ft	Serv Ft	S1–S2	# Cust
	75kVA		
60	20–40	3/0–1/0	10
60	50	3/0–1/0	10(e)
70	20–50	3/0–3/0	10
80	20–40	3/0–3/0	10
80	50	3/0–3/0	10(e)
90	20–30	3/0–3/0	10
90	40	3/0–3/0	10(e)
90	50	3/0–3/0	10(q)
100	20	3/0–3/0	10
100	30–40	3/0–3/0	10(e)
100	50	3/0–3/0	10(e)
	75kVA		
110	20–40	1/0	6
110	50	3/0	6
120	20–30	1/0	6
120	40	1/0	6(f)
120	50	3/0	6
130	20–30	1/0	6
130	40	1/0	6(f)
130	50	3/0	6
140	20–30	1/0	6
140	40–50	3/0	6
150	20–40	3/0	6
150	50	3/0	6(f)

7kW Electric Water Heater (EWH)

Sec Ft	Serv Ft	S1–S2	# Cust
	50kVA		
60	20–50	1/0–1/0	10
70	20–40	1/0–1/0	10
70	50	1/0–1/0	10(e)
80	20–50	3/0–1/0	10
90	20–30	3/0–1/0	10
90	40–50	3/0–1/0	10(e)
100	20–50	3/0–3/0	10
110	20–40	3/0–3/0	10
110	50	3/0–3/0	10(e)
120	20–30	3/0–3/0	10
120	40	3/0–3/0	8(t)
120	50	3/0–3/0	8(t)(q)
130–150	20–50	1/0	6

8kW Electric Heater(EH)

Sec Ft	Serv Ft	S1–S2–S3	# Cust
	50kVA		
60	20	3/0–1/0–1/0	14
60	30	3/0–1/0–1/0	12(u)
60	40–50	3/0–1/0–1/0	12(u)(b)
70	20–50	3/0–1/0–3/0	12(v)
	25kVA		
80–120	20–50	#2	6
130	20–40	#2	6
130	50	1/0	6
140–150	20–50	1/0	6

4.5kW A/C Option

Sec Ft	Serv Ft	S1–S2–S3	# Cust
	50kVA		
60	20	3/0–3/0–1/0	14
60	30	3/0–3/0–1/0	14(h)
60	40–50	3/0–3/0–3/0	14(h)
70	20–30	3/0–3/0–3/0	14(h)
70	40	1/0	8(f)
70	50	3/0–1/0	10(e)
80–90	30	3/0–3/0	10(e)
100–110	50	3/0–3/0	10(e)
	25kVA		
80	20	1/0	6
80	30–40	1/0	6(f)
90–100	20–40	1/0	6(f)
110	20–30	3/0	6
110	40	3/0	6(f)
120	20	3/0	6
120	30–40	3/0	6(f)
120	50	3/0	6(n)
130	20	3/0	6
130	30	3/0	6(f)
130	40–50	3/0	6(n)
140	20	3/0	6(f)
140	30–40	3/0	6(n)
140	50	350	6
150	20	3/0	6(f)
150	30	3/0	6(n)
150	40	350	6
150	50	350	6(f)

DOUBLE–SIDED

4.5kW Base Load (BL)

Sec Ft	Serv Ft	S1–S2	# Cust
	50kVA		
	80–100	1/0–1/0	20
	110–150	3/0–1/0	20
	80–100	1/0–1/0	20(e)
	110–140	3/0–1/0	20
60	150	3/0–1/0	20(e)
60			
70			
70			
70			
	80–110	3/0–1/0	20
	120–150	3/0–1/0	20(e)
	80–90	3/0–1/0	20(e)
	100–110	3/0–3/0	20
80	80–110	3/0–3/0	20
80			
90			
	25kVA		
90–100	120–150	1/0	8
100–110	80–110	1/0	8
	80–140	1/0	8
	150	1/0	8(c)
	80–120	1/0	8
130	130–150	1/0	8(c)
130	80–110	1/0	8
140	120–150	1/0	8(c)
140			
150			
150			

7kW Air Conditioning (A/C)

Sec Ft	Serv Ft	S1–S2	# Cust
	100kVA		
60	150	350–3/0	16(x)(o)
70	150	350–3/0	16(x)(p)
80	150	350–350	16(x)(o)
	75kVA		
60	80–120	1/0	12(f)
60	130–140	3/0	12(f)
70	80	3/0	12
70	90–140	3/0	12(f)
80	80	3/0	12
80	90–130	3/0	12(f)
80	140	3/0	12(n)
90	80	3/0	12
90	90–120	3/0	12(f)
90	130–150	3/0	12(n)
100	80–120	3/0	12(f)
100	130–150	3/0	12(n)
110	80–110	3/0	12(f)
110	120–150	3/0	12(n)
120	80–100	3/0	12(f)
120	110–150	3/0	12(n)
130	80–100	3/0	12(f)
130	110–150	3/0	12(n)
140	80–90	3/0	12(f)
140	100–140	3/0	12(n)
140	150	350	12(n)
150	80–90	3/0	12(f)
150	100–140	3/0	12(n)
	50kVA		
150	150	350	8(r)

7kW Electric Water Heater (EWH)

Sec Ft	Serv Ft	S1–S2	# Cust
	75kVA		
60	80	3/0–3/0	20(e)
60	90–120	3/0–3/0	16(t)(j)
60	130	3/0–3/0	16(t)(j)
60	140–150	3/0–3/0	16(t)(k)
70	80–120	3/0–3/0	16(t)(j)
70	130	3/0–3/0	16(t)(k)
70	120–150	350–3/0	16(t)(g)
80	80–90	350–3/0	16(t)(a)
80	100–150	350–3/0	16(t)(g)
	50kVA		
90	80–100	1/0	12(f)
90	110–120	3/0	12
90	130–150	3/0	12(f)
100	80–100	3/0	12
100	110–150	3/0	12(f)
110	80–90	3/0	12
110	100–150	3/0	12(f)
120	80	3/0	12
120	90–120	3/0	12(f)
120	130–150	3/0	12(n)
130	80–110	3/0	12(f)
130	120–150	3/0	12(n)
140	80–100	3/0	12(f)
140	110–150	3/0	12(n)
150	80	3/0	12(f)
150	90–150	3/0	12(n)

8kW Electric Heater(EH)

Sec Ft	Serv Ft	S1–S2	# Cust
	75kVA		
60	80–110	3/0–3/0	20
60	120–150	3/0–3/0	20(e)
70	80	3/0–3/0	20
70	90–100	3/0–3/0	20(e)
70	110	1/0	12
	50kVA		
70	120–150	1/0	12
80	120–140	1/0	12
80	150	1/0	12(f)
90	80–120	1/0	12
90	130–150	1/0	12(f)
100	80–110	1/0	12
100	120–150	1/0	12(f)
110	80	1/0	12
110	90–150	1/0	12(f)
120	80–120	1/0	12
120	130–150	3/0	12(f)
130	80	1/0	12(f)
130	90–140	3/0	12
130	150	3/0	12(f)
140	80–120	3/0	12
140	130–150	3/0	12(f)
150	80–110	3/0	12
150	120–150	3/0	12(f)

4.5kW A/C Option

Sec Ft	Serv Ft	S1–S2–S3	# Cust
	75kVA		
60	80–110	3/0–1/0	20(e)
60	110–150	3/0–3/0	20(a)
70	60–90	3/0–3/0	20(e)
70	100–150	3/0–3/0	20(a)
80	80	3/0–3/0	20(e)
80	90–130	3/0–1/0	20(a)
80	140–150	350–3/0	20(a)
90	80	3/0–3/0	20(a)
90	90–120	3/0–3/0	20(a)#
90	130–150	350–3/0	20(a)
100	110	3/0–3/0	20(a)#
100	120–130	350–3/0	20(a)
110	100–110	350–3/0	20(a)(n)
	50kVA		
100	80–100	3/0	12(e)
100	140–150	3/0	12(n)
110	80–90	3/0	12(e)
110	120–150	3/0	12(n)
120	80–90	3/0	12(e)
120	100–150	3/0	12(n)
130	80–90	3/0	12(e)
130	100–140	3/0	12(n)
130	150	350	8(r)
140	80–120	3/0	12(n)
140	130–150	350	8(r)
150	80–110	3/0	12(n)#
150	120	350	8(f)
150	130–150	350	8(r)

H2–H5 SHORT=1/0–1/0
H1–H4 SHORT=1/0–1/0

a)H2=1/0, b)H3=1/0, c)H1=1/0, d)H4=1/0, e)H2–H5=1/0–1/0, f)H1–H4=1/0–1/0, g)H2–H4=1/0–1/0
h)H3–H8=1/0–1/0, i)H3–H5=1/0–1/0, j)H2=3/0, l)H3–H5=3/0–1/0, m)H2–H4=1/0–3/0, n)H1–H4=3/0–3/0
o)H2–H5=3/0–3/0, p)H2–H4=3/0–3/0, q)H1–H2–H4=1/0–1/0–1/0, r)H1=3/0
s)S4=#2, t)S4–1/0, u)S4–S5=1/0–#2, v)S4–S5=1/0–1/0, w)S2–S4=3/0–1/0, x)S4=3/0

REV	CHANGE	BY	DSGN	APPV	DATE	REV	CHANGE	BY	DSGN	APPV	DATE
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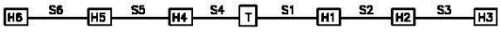

H1–H4 SHORT=1/0–1/0

Sq. Ft.: 0–1299

SINGLE–SIDED

6.5kW EH & EWH

Sec Ft	Serv Ft	S1–S2–S3	# Cust
	50kVA		
60	20	3/0–3/0–1/0	14
60	30–50	1/0–1/0	10
70	20–50	1/0–1/0	10
80	20	3/0–1/0	10
	25kVA		
80	30–50	#2	6
90–110	20–50	#2	6
120–150	20–50	1/0	6

6kW A/C & EWH

Sec Ft	Serv Ft	S1–S2	# Cust
	50kVA		
60–70	20–50	1/0–1/0	10
80	20–50	1/0–1/0	10(e)
90	20	3/0–1/0	10
90	30–50	3/0–1/0	10(e)
100	20	3/0–3/0	10
100	30–50	3/0–3/0	10(e)
110	20–50	3/0–3/0	10(e)
120	20–40	3/0–3/0	8(f)
120	50	3/0–3/0	8(a)
	25kVA		
130	20–40	1/0	6
130	50	1/0	6
140–150	20–40	1/0	6
140–150	50	1/0	6(f)

Sq. Ft.: 1300–1999

SINGLE–SIDED

7.5kW EH & EWH

Sec Ft	Serv Ft	S1–S2	# Cust
	50kVA		
60	20–30	1/0–1/0	10
60	40–50	1/0–1/0	10(e)
70	20–50	3/0–1/0	10
80–90	20–50	3/0–3/0	10
100	20	3/0–3/0	10
100	30–50	3/0–3/0	10(e)
110	20–40	3/0–3/0	10(e)
110	50	3/0–3/0	8(f)(f)
120–150	20–50	1/0	6

7kW A/C & EWH

Sec Ft	Serv Ft	S1–S2	# Cust
	75kVA		
60	20–40	3/0–1/0	10
60	50	3/0–1/0	10(e)
70	20–50	3/0–3/0	10
80	20–40	3/0–3/0	10
80	50	3/0–3/0	10(e)
90	20–30	3/0–3/0	10
90	40	3/0–3/0	10(e)
90	50	3/0–3/0	10(a)
100	20	3/0–3/0	10
100	30–40	3/0–3/0	10(e)
100	50	3/0–3/0	10(e)
	50kVA		
110	20–40	1/0	6
110	50	3/0	6
120	20–30	1/0	6
120	40	1/0	6(f)
120	50	3/0	6
130	20–30	1/0	6
130	40	1/0	6(f)
130	50	3/0	6
140	20–30	1/0	6
140	40–50	3/0	6
150	20–40	3/0	6
150	50	3/0	6(f)

Sq. Ft.: 2000–2999

SINGLE–SIDED

8kW EH & EWH

Sec Ft	Serv Ft	S1–S2	# Cust
	50kVA		
60	20	1/0–1/0	10
60	30–50	1/0–1/0	10(e)
70	20–50	3/0–1/0	10
80	20–50	3/0–3/0	10
90	20	3/0–3/0	10
90	30–50	3/0–3/0	10(e)
100	20	3/0–3/0	10
100	30	3/0–3/0	8(a)(t)
100	40–50	3/0–3/0	8(t)(t)
110–150	20–50	1/0	6

8kW A/C & EWH

Sec Ft	Serv Ft	S1–S2	# Cust
	75kVA		
60	20–40	3/0–1/0	10
60	50	3/0–1/0	10(e)
70	20–30	3/0–1/0	10
70	40–50	3/0–1/0	10(e)
80	20–40	3/0–3/0	10
80	50	3/0–3/0	10(e)
90	20–30	3/0–3/0	10
90	40	3/0–3/0	10(e)
90	50	3/0–3/0	10(a)
100	20	3/0–3/0	10
100	30	3/0–3/0	10(e)
100	50	3/0–3/0	10(a)
	50kVA		
100	40	1/0	6
110	20–30	1/0	6
110	40–50	1/0	6(f)
120	20–30	1/0	6
120	40–50	1/0	6(f)
130	20	1/0	6
130	30–40	1/0	6(f)
130	50	3/0	6
140	20	1/0	6
140	30	1/0	6(f)
140	40–50	3/0	6
150	20	1/0	6(f)
150	30–40	3/0	6
150	50	3/0	6(f)

a)H2=1/0, b)H3=1/0, c)H1=1/0, d)H4=1/0, e)H2–H5=1/0–1/0, f)H1–H4=1/0–1/0, g)H2–H4=1/0–1/0
h)H3–H6=1/0–1/0, i)H3–H5=1/0–1/0, j)H2=3/0, l)H3–H5=3/0–1/0, m)H2–H4=1/0–3/0, n)H1–H4=3/0–3/0
o)H2–H5=3/0–3/0, p)H2–H4=3/0–3/0, q)H1–H2–H4=1/0–1/0–1/0, r)H1=3/0
s)S4=#2, t)S4–1/0, u)S4–S5=1/0–#2, v)S4–S5=1/0–1/0, w)S2–S4=3/0–1/0, x)S4=3/0

DOUBLE–SIDED

6.5kW EH & EWH

Sec Ft	Serv Ft	S1–S2	# Cust
	75kVA		
60	80–90	3/0–3/0	20
60	100–150	3/0–3/0	20(e)
70	80–100	3/0–3/0	20(e)
	50kVA		
70	110–150	1/0	12
80	80–110	1/0	12
80	120–150	1/0	12(f)
90	80–100	1/0	12
90	110–150	1/0	12(f)
100	80	1/0	12
100	90–150	1/0	12(f)
110	80–110	1/0	12(f)
110	120–140	3/0	12
110	150	3/0	12(f)
120	80–110	3/0	12
120	120–150	3/0	12(f)
130	80–110	3/0	12
130	120–150	3/0	12(f)
140	80–100	3/0	12
140	100–150	3/0	12(f)
150	80–90	3/0	12
150	100–150	3/0	12(f)

6kW A/C & EWH

Sec Ft	Serv Ft	S1–S2	# Cust
	75kVA		
60	80–100	3/0–3/0	16(a)(t)
60	110–150	3/0–3/0	16(g)(t)
70	80–100	1/0	12
70	110–150	350–3/0	16(g)(t)
80	80–90	1/0	12
80	100–130	350–3/0	16(g)(t)
80	140–150	3/0	12(f)
90	80–90	1/0	12
90	100–150	1/0	12(f)
100	80	1/0	12
100	90–130	1/0	12(f)
100	140–150	3/0	12(f)
110	80–130	1/0	12(f)
110	140–150	3/0	12(f)
120	80–110	1/0	12(f)
120	120–140	3/0	12(f)
120	150	3/0	12(n)
130	80–90	3/0	12
130	100–150	3/0	12(f)
130	140–150	3/0	12(n)
140	80–100	3/0	12
140	100–130	3/0	12(f)
140	140–150	3/0	12(n)
150	80–90	3/0	12
150	100–120	3/0	12(f)
150	130–150	3/0	12(n)

7.5kW EH & EWH

Sec Ft	Serv Ft	S1–S2	# Cust
	75kVA		
60	80–100	3/0–3/0	16(t)(a)
60	100–120	3/0–3/0	16(t)(j)
60	130–150	3/0–3/0	16(t)(k)
70	80	3/0–3/0	16(t)(j)
70	90	350–3/0	16(t)
70	100–150	350–3/0	16(t)(a)
80	80–110	350–3/0	16(t)(g)
80	120–140	350–3/0	16(t)(k)
	50kVA		
80	150	3/0	12(f)
90	80–90	3/0	12
90	100	3/0	12(f)
90	110–150	3/0	12(f)
100	80–100	3/0	12
100	110–150	3/0	12(f)
110	80–130	3/0	12(f)
110	140–150	3/0	8(c)
120	80–110	3/0	12(f)
120	120–150	3/0	8(c)
130	80	3/0	12(n)
130	90	3/0	12(f)
130	100–130	3/0	8(c)
130	140–150	3/0	12(n)
140	80	3/0	12(n)
140	90–110	3/0	8(c)
140	120	3/0	12(n)
140	130–150	3/0	9(r)

7kW A/C & EWH

Sec Ft	Serv Ft	S1–S2	# Cust
	100kVA		
60	150	350–3/0	16(x)(a)
70	150	350–3/0	16(x)(p)
80	150	350–350	16(x)(a)
	75kVA		
60	80–120	1/0	12(f)
60	130–140	3/0	12(f)
70	80	3/0	12
70	90–140	3/0	12(f)
80	80	3/0	12
80	90–130	3/0	12(f)
80	140	3/0	12(n)
90	80	3/0	12
90	90–120	3/0	12(f)
90	130–150	3/0	12(n)
100	80–120	3/0	12(f)
100	130–150	3/0	12(n)
110	80–110	3/0	12(f)
110	120–150	3/0	12(n)
120	80–100	3/0	12(f)
120	110–150	3/0	12(n)
130	80–100	3/0	12(f)
130	110–150	3/0	12(n)
140	80–90	3/0	12(f)
140	100–140	3/0	12(n)
140	150	350	12(n)
150	80–90	3/0	12(f)
150	100–140	3/0	12(n)
		350	8(r)

8kW EH & EWH

Sec Ft	Serv Ft	S1–S2	# Cust
	75kVA		
60	80–100	3/0–3/0	16(t)(j)
60	110	3/0–3/0	16(t)(r)
60	120–140	350–3/0	16(t)(q)
60	150	350–3/0	16(t)(q)
70	80	350–3/0	16(t)(q)
70	90–120	350–3/0	16(t)(q)
70	130–140	350–3/0	16(t)(k)
	50kVA		
70	150	3/0	12(f)
80	80–100	3/0	12
80	110–150	3/0	12(f)
90	80–90	3/0	12
90	100–140	3/0	12(f)
90	150	3/0	8(c)
100	80	3/0	12
100	90–140	3/0	12(f)
100	150	3/0	8(c)
110	80–110	3/0	12(f)
110	120	3/0	12(n)
110	130–150	3/0	8(c)
120	80–90	3/0	12(f)
120	100	3/0	8(c)
120	110–140	3/0	12(n)
120	150	3/0	8(c)
130	80–120	3/0	12(n)
130	130–150	3/0	8(r)
140	80	3/0	12(n)
140	90–150	3/0	8(r)
150	80–100	3/0	8(r)
150	110–150	350	12(f)

8kW A/C & EWH

Sec Ft	Serv Ft	S1–S2	# Cust
	75kVA		
60	80–90	3/0	12
60	100–140	3/0	12(f)
60	150	350–3/0	20(a)
70	80	3/0	12
70	90–140	3/0	12(f)
70	150	3/0	12(n)
80	80	3/0	12
80	90–130	3/0	12(f)
80	140–150	3/0	12(n)
90	80	3/0	12
90	90–120	3/0	12(f)
90	130–150	3/0	12(n)
100	80–120	3/0	12(f)
100	130–150	3/0	12(n)
110	80–110	3/0	12(f)
110	120–150	3/0	12(n)
120	80–100	3/0	12(f)
120	110–150	3/0	12(n)
130	80	350	12
130	90–140	350	12(f)
140	80	350	12
140	90–130	350	12(f)
140	140	350	12(n)
150	80	350	12
150	90–130	350	12(f)
	50kVA		
130	150	350	12(n)
140	150	350	12(n)
150	140–150	350	8(r)

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REV	CHANGE	BY	DSGN	APPV	DATE	REV	CHANGE	BY	DSGN	APPV	DATE
C						F					
B	FORMATTING	JIK	-	-	02/21/2020	E					
A	ORIGINAL ISSUE	-	CVN	RDG	01/01/1987	D					

X Indicates Latest Revision | Completely Revised | New Page | Information Removed

SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL FIELD MAINTENANCE ONLY

SINGLE FAMILY RESIDENTIAL SECONDARY SYSTEMS

FMO DM5223.7

5300
DEMAND
ESTIMATING

5300
DEMAND
ESTIMATING

5300 - No FMO standards for this section.

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5400
VOLTAGE DROP

5400
VOLTAGE DROP

PAGE	SUBJECT

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C							F						
B							E						
A	5431 AND 5432 MOVED TO FMO	YZZ	FRC	FRC	FRC	11/06/2025	D						

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

DM5431 FIELD MAINTENANCE ONLY

ALL VERSIONS LISTED IN FMO ARE SUPERSEDED BY THEIR CURRENT VERSION FOUND INSIDE THE ELECTRIC DISTRIBUTION DESIGN MANUAL.

REVISION HISTORY:

11/06 /2025: MOVED TO FMO

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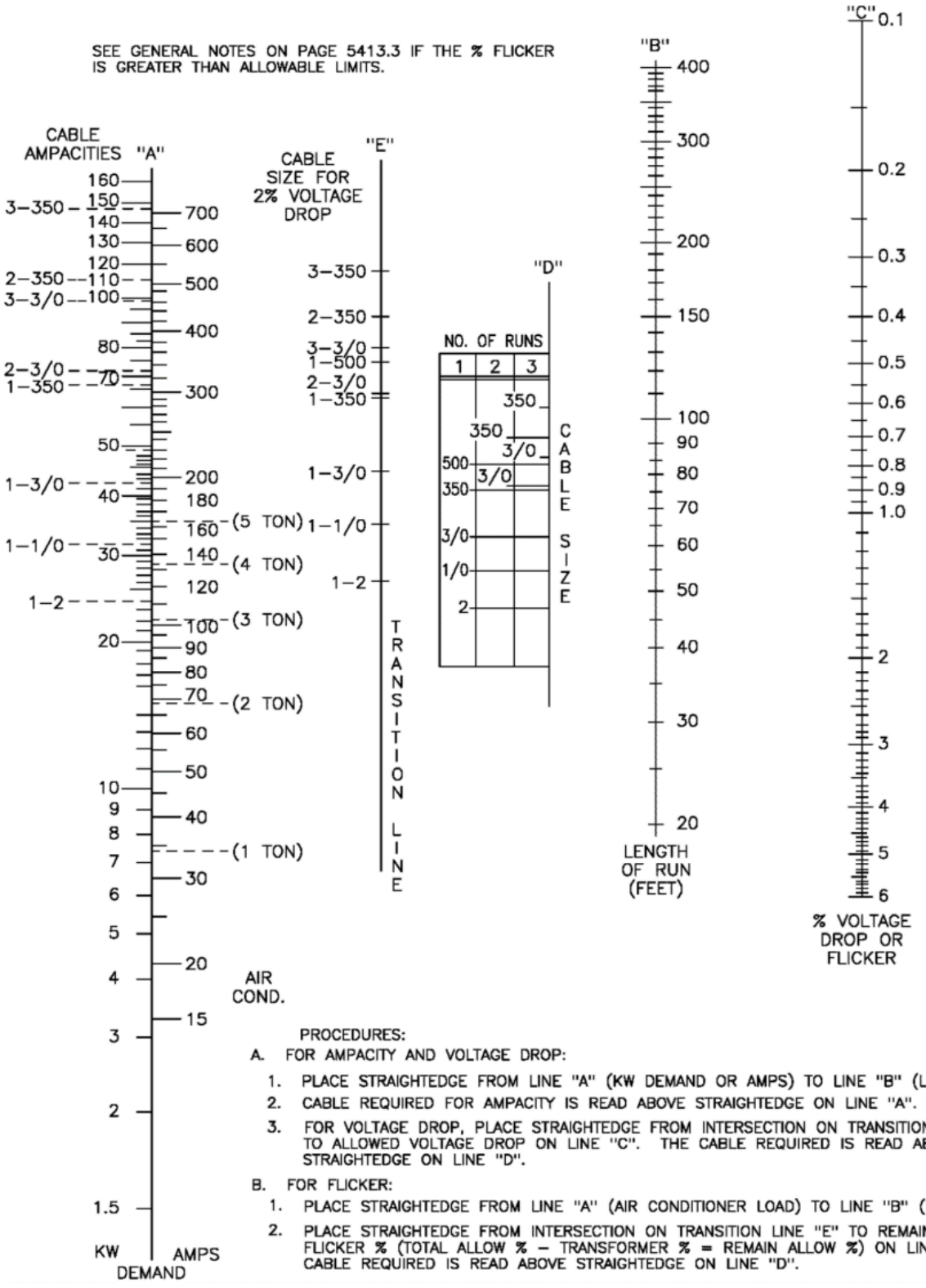
REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C							F						
B							E						
A	5431 MOVED TO FMO	YZZ	FRC	FRC	FRC	11/06/2025	D						

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

SEE GENERAL NOTES ON PAGE 5413.3 IF THE % FLICKER IS GREATER THAN ALLOWABLE LIMITS.



PROCEDURES:

A. FOR AMPACITY AND VOLTAGE DROP:

1. PLACE STRAIGHTEDGE FROM LINE "A" (KW DEMAND OR AMPS) TO LINE "B" (LENGTH OF RUN).
2. CABLE REQUIRED FOR AMPACITY IS READ ABOVE STRAIGHTEDGE ON LINE "A".
3. FOR VOLTAGE DROP, PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO ALLOWED VOLTAGE DROP ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

B. FOR FLICKER:

1. PLACE STRAIGHTEDGE FROM LINE "A" (AIR CONDITIONER LOAD) TO LINE "B" (LENGTH OF RUN).
2. PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO REMAINING ALLOWABLE FLICKER % (TOTAL ALLOW % – TRANSFORMER % = REMAIN ALLOW %) ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C							F						
B							E						
A	5431 MOVED TO FMO	YZZ	FRC	FRC	FRC	11/06/2025	D						

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL FIELD MAINTENANCE ONLY

SINGLE-PHASE 120/240V UNDERGROUND VOLTAGE DROP AND FLICKER NOMOGRAPH

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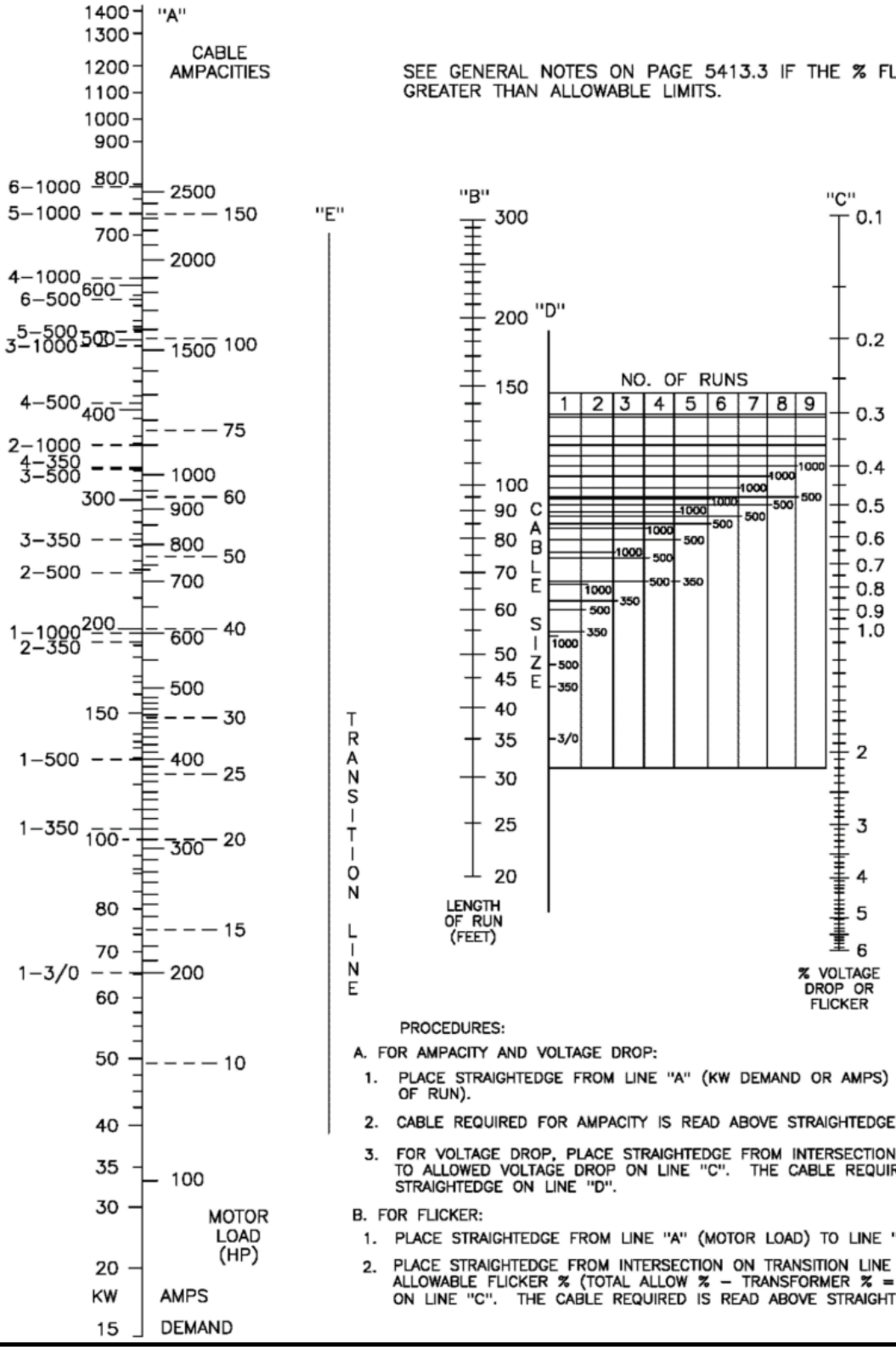

SEE GENERAL NOTES ON PAGE 5413.3 IF THE % FLICKER IS GREATER THAN ALLOWABLE LIMITS.

PROCEDURES:

A. FOR AMPACITY AND VOLTAGE DROP:

1. PLACE STRAIGHTEDGE FROM LINE "A" (KW DEMAND OR AMPS) TO LINE "B" (LENGTH OF RUN).
2. CABLE REQUIRED FOR AMPACITY IS READ ABOVE STRAIGHTEDGE ON LINE "A"
3. FOR VOLTAGE DROP, PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO ALLOWED VOLTAGE DROP ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

B. FOR FLICKER:

1. PLACE STRAIGHTEDGE FROM LINE "A" (MOTOR LOAD) TO LINE "B" (LENGTH OF RUN).
2. PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO REMAINING ALLOWABLE FLICKER % (TOTAL ALLOW % – TRANSFORMER % = REMAIN ALLOW %) ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C							F						
B							E						
A	5431 MOVED TO FMO	YZZ	FRC	FRC	FRC	11/06/2025	D						

Indicates Latest Revision | Completely Revised | X | New Page | Information Removed

SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL FIELD MAINTENANCE ONLY

SHEET 2 OF 5

3Ø 120/208Y UNDERGROUND VOLTAGE DROP AND FLICKER NOMOGRAPH

FMO DM5431.2

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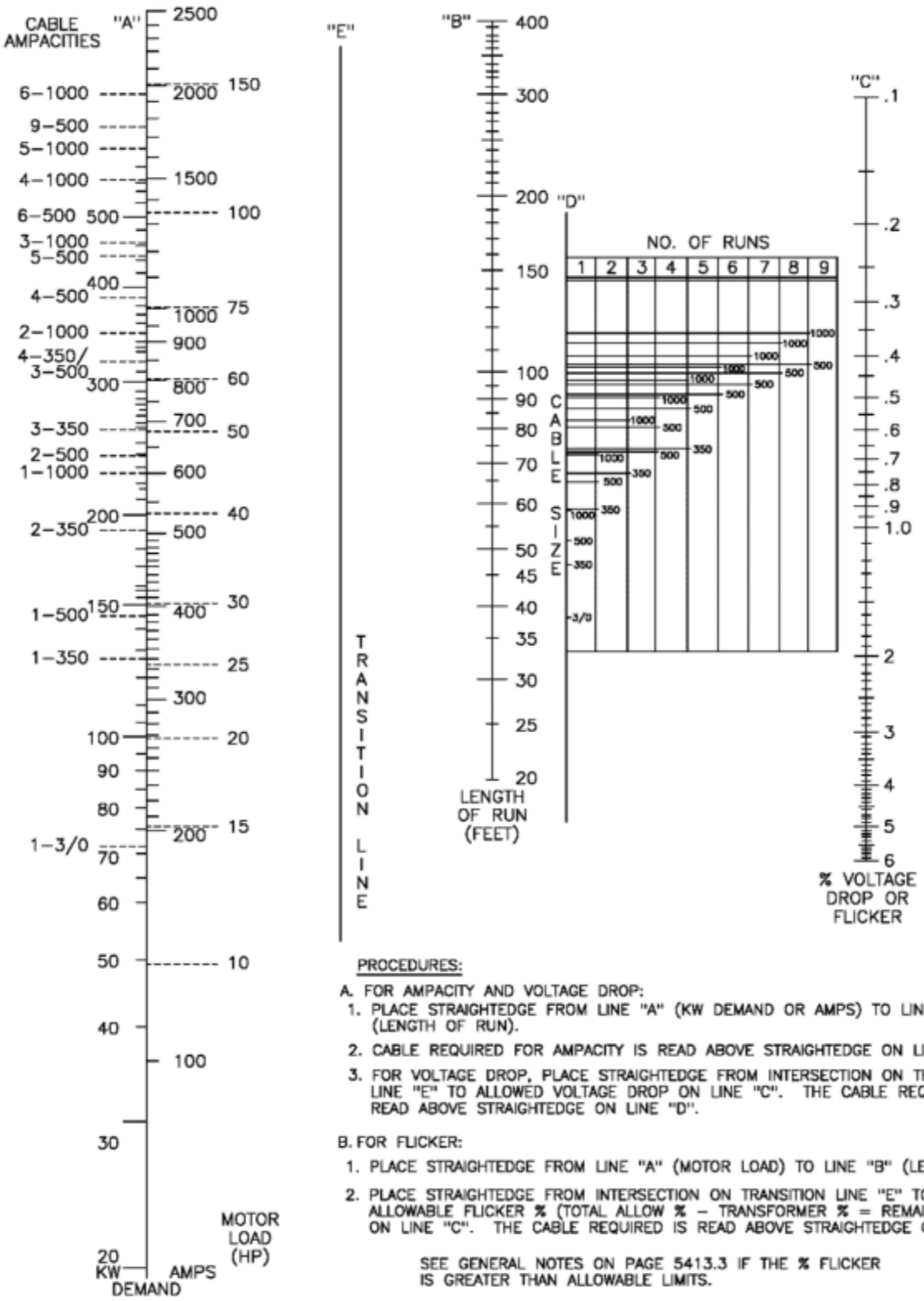

PROCEDURES:

A. FOR AMPACITY AND VOLTAGE DROP:
1. PLACE STRAIGHTEDGE FROM LINE "A" (KW DEMAND OR AMPS) TO LINE "B" (LENGTH OF RUN).
2. CABLE REQUIRED FOR AMPACITY IS READ ABOVE STRAIGHTEDGE ON LINE "A"
3. FOR VOLTAGE DROP, PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO ALLOWED VOLTAGE DROP ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

B. FOR FLICKER:
1. PLACE STRAIGHTEDGE FROM LINE "A" (MOTOR LOAD) TO LINE "B" (LENGTH OF RUN).
2. PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO REMAINING ALLOWABLE FLICKER % (TOTAL ALLOW % – TRANSFORMER % = REMAIN ALLOW %) ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

SEE GENERAL NOTES ON PAGE 5413.3 IF THE % FLICKER IS GREATER THAN ALLOWABLE LIMITS.

REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C							F						
B							E						
A	5431 MOVED TO FMO	YZZ	FRC	FRC	FRC	11/06/2025	D						

Indicates Latest Revision | Completely Revised | X | New Page | Information Removed

SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL FIELD MAINTENANCE ONLY

SHEET 3 OF 5

3Ø 120/240V UNDERGROUND VOLTAGE DROP AND FLICKER NOMOGRAPH

FMO DM5431.3

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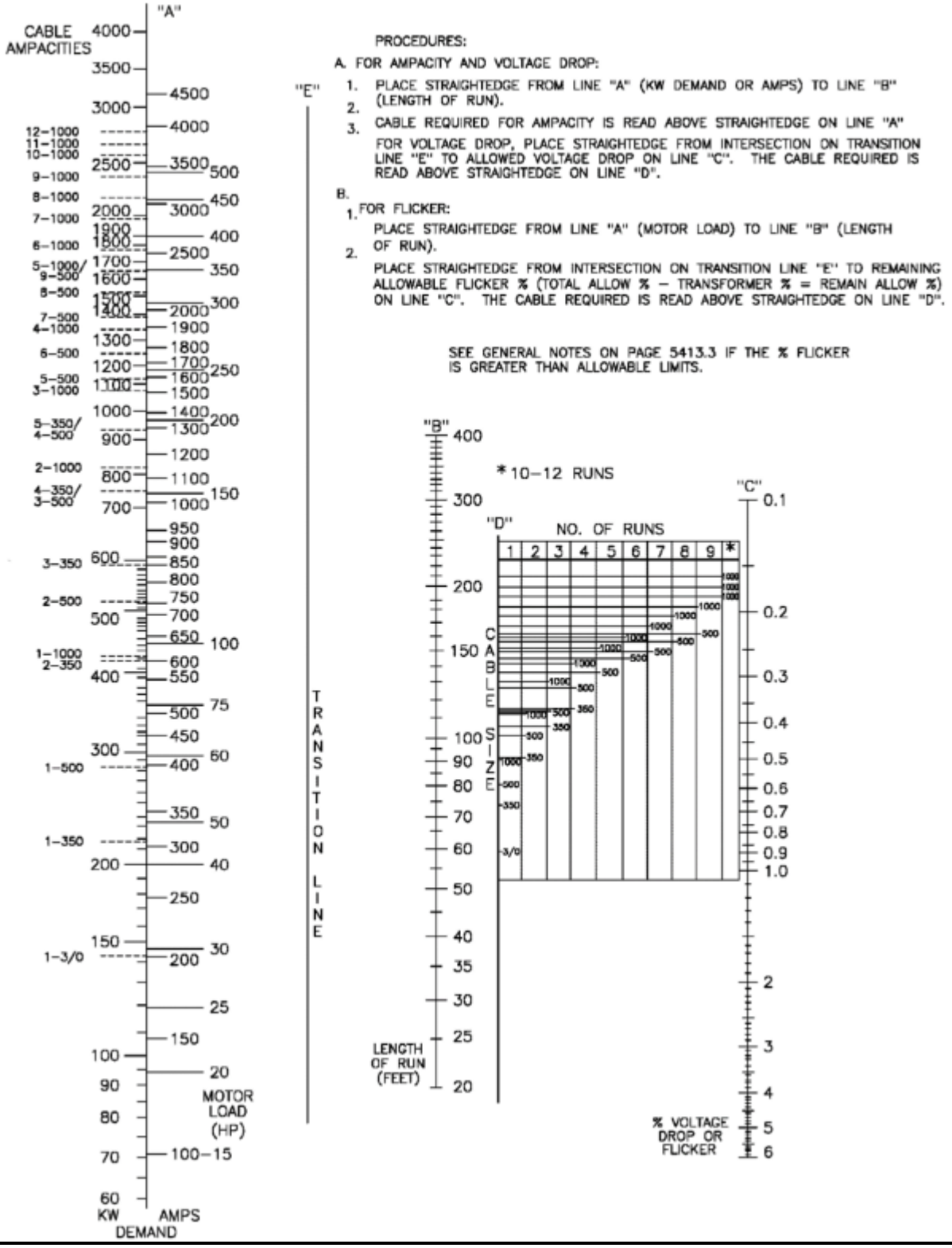

PROCEDURES:

A. FOR AMPACITY AND VOLTAGE DROP:

1. PLACE STRAIGHTEDGE FROM LINE "A" (KW DEMAND OR AMPS) TO LINE "B" (LENGTH OF RUN).
2.
3. CABLE REQUIRED FOR AMPACITY IS READ ABOVE STRAIGHTEDGE ON LINE "A"

FOR VOLTAGE DROP, PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO ALLOWED VOLTAGE DROP ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

B.

1. FOR FLICKER:

PLACE STRAIGHTEDGE FROM LINE "A" (MOTOR LOAD) TO LINE "B" (LENGTH OF RUN).

2.

PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO REMAINING ALLOWABLE FLICKER % (TOTAL ALLOW % – TRANSFORMER % = REMAIN ALLOW %) ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

SEE GENERAL NOTES ON PAGE 5413.3 IF THE % FLICKER IS GREATER THAN ALLOWABLE LIMITS.

REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C							F						
B							E						
A	5431 MOVED TO FMO	YZZ	FRC	FRC	FRC	11/06/2025	D						

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL FIELD MAINTENANCE ONLY

3Ø 277/480Y UNDERGROUND NOMOGRAPH

FMO DM5431.4

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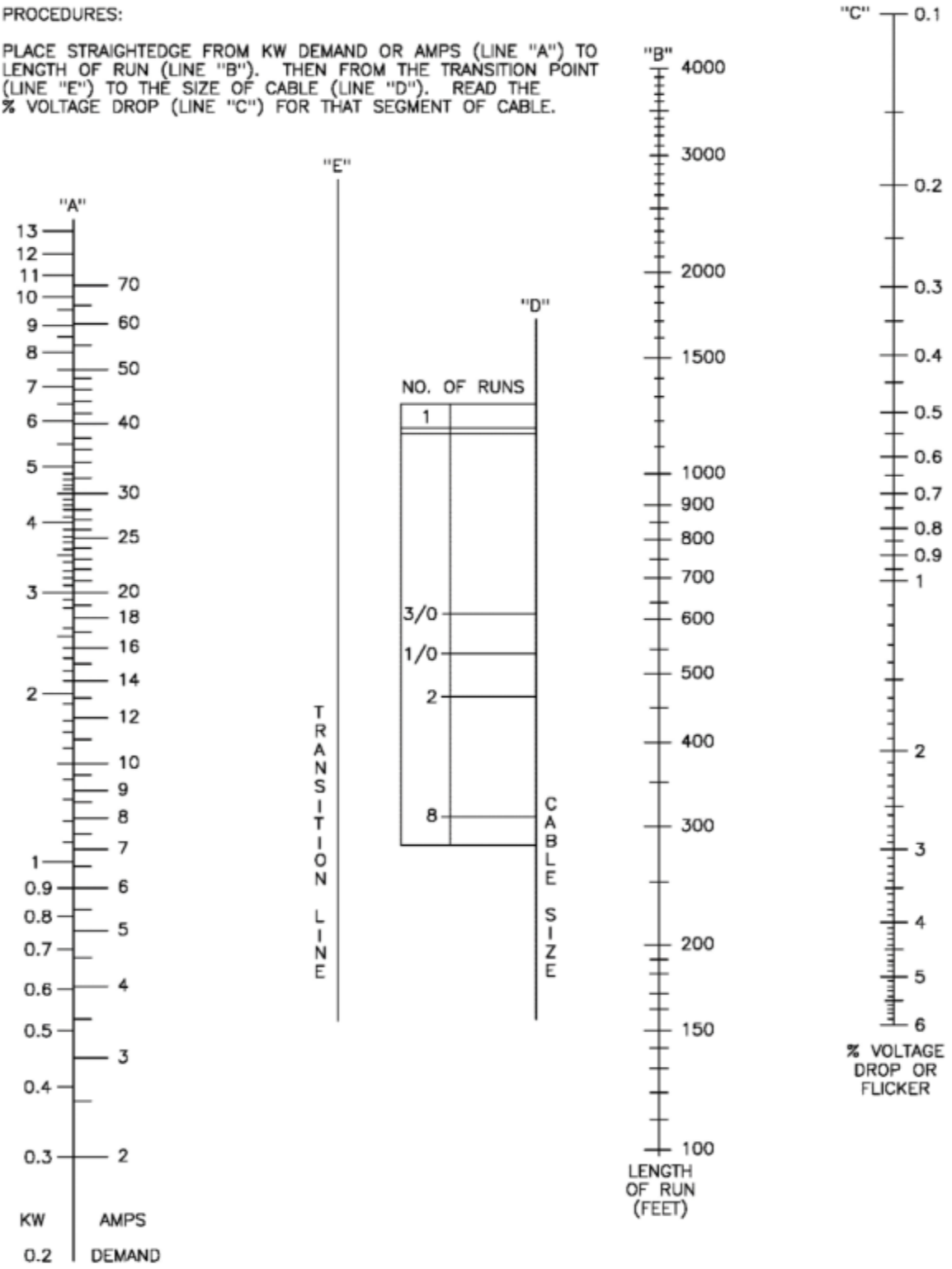
PROCEDURES:

PLACE STRAIGHTEDGE FROM KW DEMAND OR AMPS (LINE "A") TO LENGTH OF RUN (LINE "B"). THEN FROM THE TRANSITION POINT (LINE "E") TO THE SIZE OF CABLE (LINE "D"). READ THE % VOLTAGE DROP (LINE "C") FOR THAT SEGMENT OF CABLE.



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REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C							F						
B							E						
A	5431 MOVED TO FMO	YZZ	FRC	FRC	FRC	11/06/2025	D						

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL FIELD MAINTENANCE ONLY

SHEET 5 OF 5

SINGLE-PHASE 120/240V UNDERGROUND STREET LIGHT NOMOGRAPH

FMO DM5431.5

DM5432 FIELD MAINTENANCE ONLY

ALL VERSIONS LISTED IN FMO ARE SUPERSEDED BY THEIR CURRENT VERSION FOUND INSIDE THE ELECTRIC DISTRIBUTION DESIGN MANUAL.

REVISION HISTORY:

11/06/2025: MOVED TO FMO

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REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C							F						
B							E						
A	5432 MOVED TO FMO	YZZ	FRC	FRC	FRC	11/06/2025	D						

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

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PROCEDURES:

A. FOR AMPACITY AND VOLTAGE DROP:

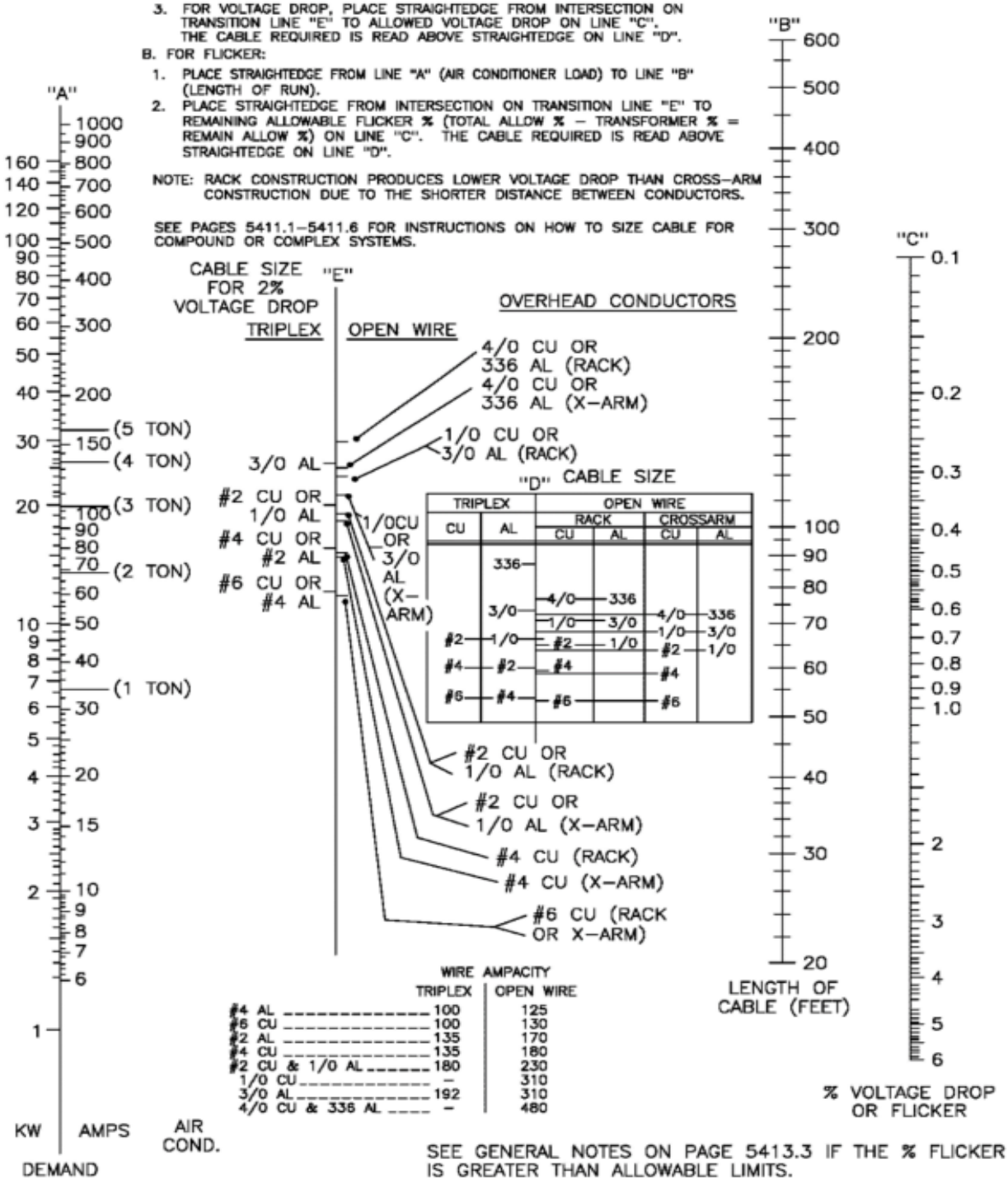
1. PLACE STRAIGHTEDGE FROM LINE "A" (KW DEMAND OR AMPS) TO LINE "B" (LENGTH OF RUN).
2. WIRE REQUIRED FOR AMPACITY IS READ OFF TABLE BELOW.
3. FOR VOLTAGE DROP, PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO ALLOWED VOLTAGE DROP ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

B. FOR FLICKER:

1. PLACE STRAIGHTEDGE FROM LINE "A" (AIR CONDITIONER LOAD) TO LINE "B" (LENGTH OF RUN).
2. PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO REMAINING ALLOWABLE FLICKER % (TOTAL ALLOW % – TRANSFORMER % = REMAIN ALLOW %) ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

NOTE: RACK CONSTRUCTION PRODUCES LOWER VOLTAGE DROP THAN CROSS-ARM CONSTRUCTION DUE TO THE SHORTER DISTANCE BETWEEN CONDUCTORS.

SEE PAGES 5411.1–5411.6 FOR INSTRUCTIONS ON HOW TO SIZE CABLE FOR COMPOUND OR COMPLEX SYSTEMS.



SEE GENERAL NOTES ON PAGE 5413.3 IF THE % FLICKER IS GREATER THAN ALLOWABLE LIMITS.

REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C							F						
B							E						
A	5432 MOVED TO FMO	YZZ	FRC	FRC	FRC	11/06/2025	D						

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL FIELD MAINTENANCE ONLY

SINGLE-PHASE 120/240V OVERHEAD VOLTAGE DROP AND FLICKER NOMOGRAPH

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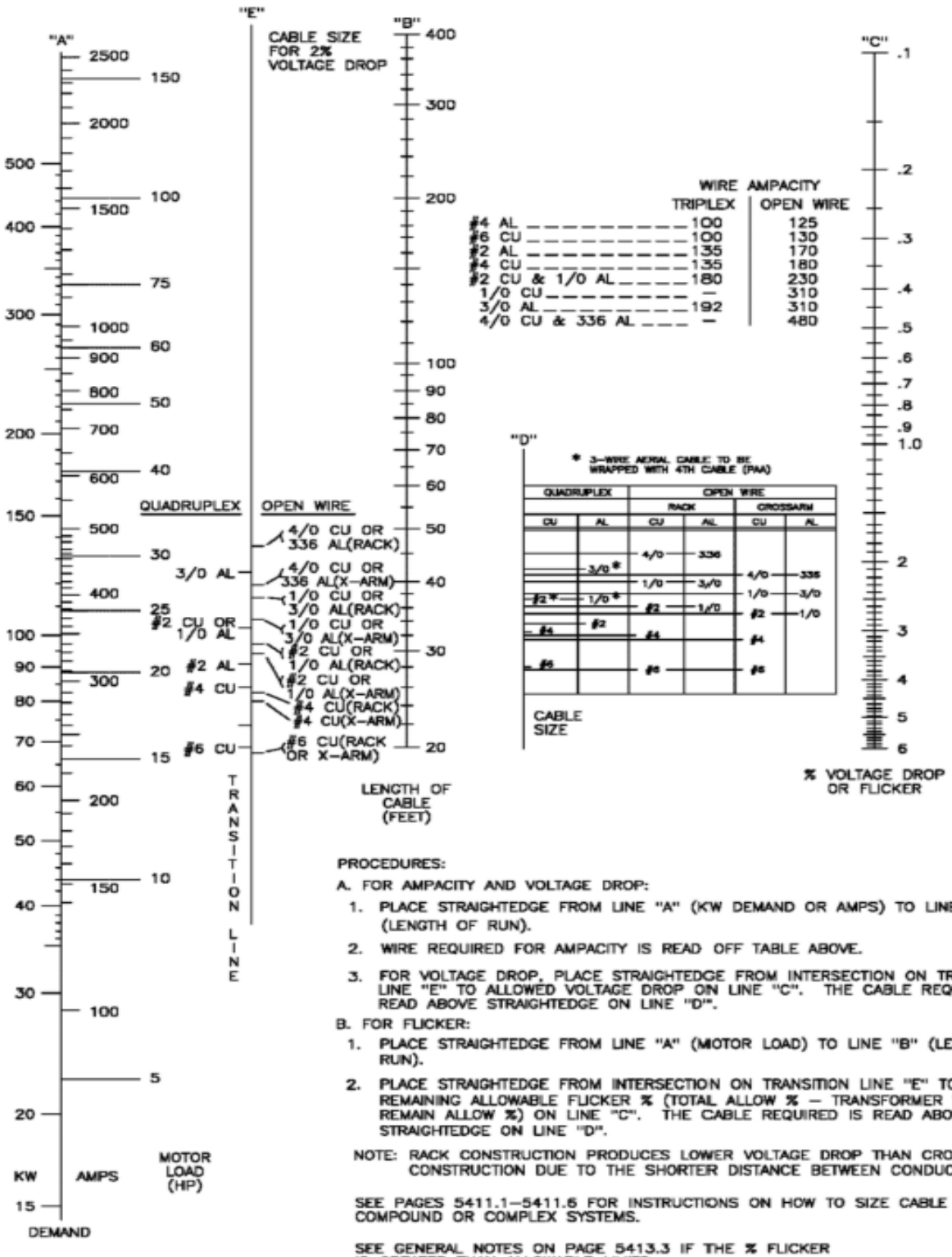

PROCEDURES:

A. FOR AMPACITY AND VOLTAGE DROP:

1. PLACE STRAIGHTEDGE FROM LINE "A" (KW DEMAND OR AMPS) TO LINE "B" (LENGTH OF RUN).
2. WIRE REQUIRED FOR AMPACITY IS READ OFF TABLE ABOVE.
3. FOR VOLTAGE DROP, PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO ALLOWED VOLTAGE DROP ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

B. FOR FLICKER:

1. PLACE STRAIGHTEDGE FROM LINE "A" (MOTOR LOAD) TO LINE "B" (LENGTH OF RUN).
2. PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO REMAINING ALLOWABLE FLICKER % (TOTAL ALLOW % – TRANSFORMER % = REMAIN ALLOW %) ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

NOTE: RACK CONSTRUCTION PRODUCES LOWER VOLTAGE DROP THAN CROSS-ARM CONSTRUCTION DUE TO THE SHORTER DISTANCE BETWEEN CONDUCTORS.

SEE PAGES 5411.1–5411.6 FOR INSTRUCTIONS ON HOW TO SIZE CABLE FOR COMPOUND OR COMPLEX SYSTEMS.

SEE GENERAL NOTES ON PAGE 5413.3 IF THE % FLICKER IS GREATER THAN ALLOWABLE LIMITS.

REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C							F						
B							E						
A	5432 MOVED TO FMO	YZZ	FRC	FRC	FRC	11/06/2025	D						

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL FIELD MAINTENANCE ONLY

SHEET 2 OF 4

THREE PHASE 120/208Y OVERHEAD VOLTAGE DROP AND FLICKER NOMOGRAPH

FMO DM5432.2

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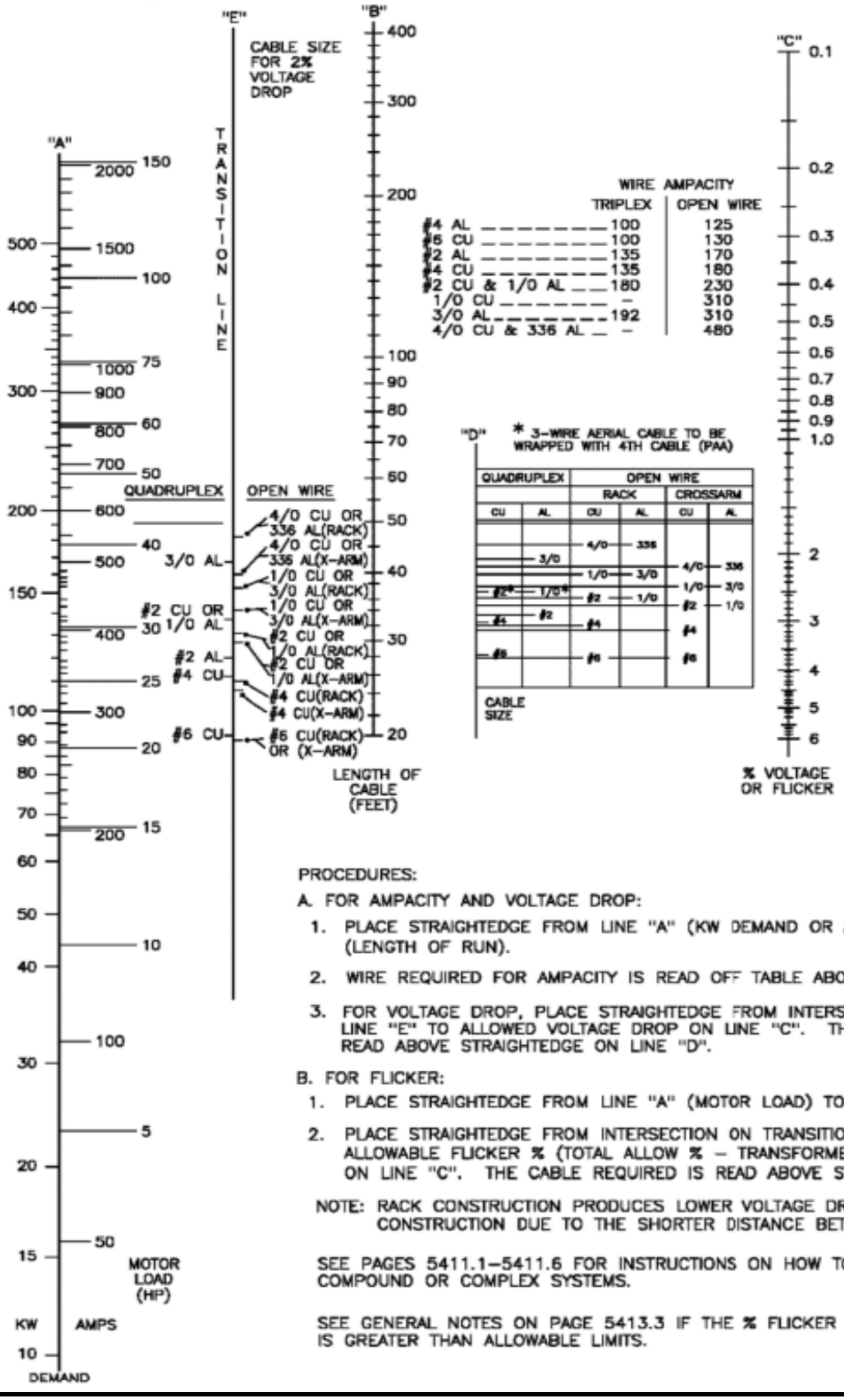

PROCEDURES:

A. FOR AMPACITY AND VOLTAGE DROP:

1. PLACE STRAIGHTEDGE FROM LINE "A" (KW DEMAND OR AMPS) TO LINE "B" (LENGTH OF RUN).
2. WIRE REQUIRED FOR AMPACITY IS READ OFF TABLE ABOVE.
3. FOR VOLTAGE DROP, PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO ALLOWED VOLTAGE DROP ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

B. FOR FLICKER:

1. PLACE STRAIGHTEDGE FROM LINE "A" (MOTOR LOAD) TO LINE "B" (LENGTH OF RUN).
2. PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO REMAINING ALLOWABLE FLICKER % (TOTAL ALLOW % – TRANSFORMER % = REMAIN ALLOW %) ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

NOTE: RACK CONSTRUCTION PRODUCES LOWER VOLTAGE DROP THAN CROSS-ARM CONSTRUCTION DUE TO THE SHORTER DISTANCE BETWEEN CONDUCTORS.

SEE PAGES 5411.1–5411.6 FOR INSTRUCTIONS ON HOW TO SIZE CABLE FOR COMPOUND OR COMPLEX SYSTEMS.

SEE GENERAL NOTES ON PAGE 5413.3 IF THE % FLICKER IS GREATER THAN ALLOWABLE LIMITS.

REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C							F						
B							E						
A	5432 MOVED TO FMO	YZZ	FRC	FRC	FRC	11/06/2025	D						

Indicates Latest Revision | Completely Revised | X New Page | Information Removed

SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL FIELD MAINTENANCE ONLY

THREE PHASE 120/240V OVERHEAD VOLTAGE DROP AND FLICKER NOMOGRAPH

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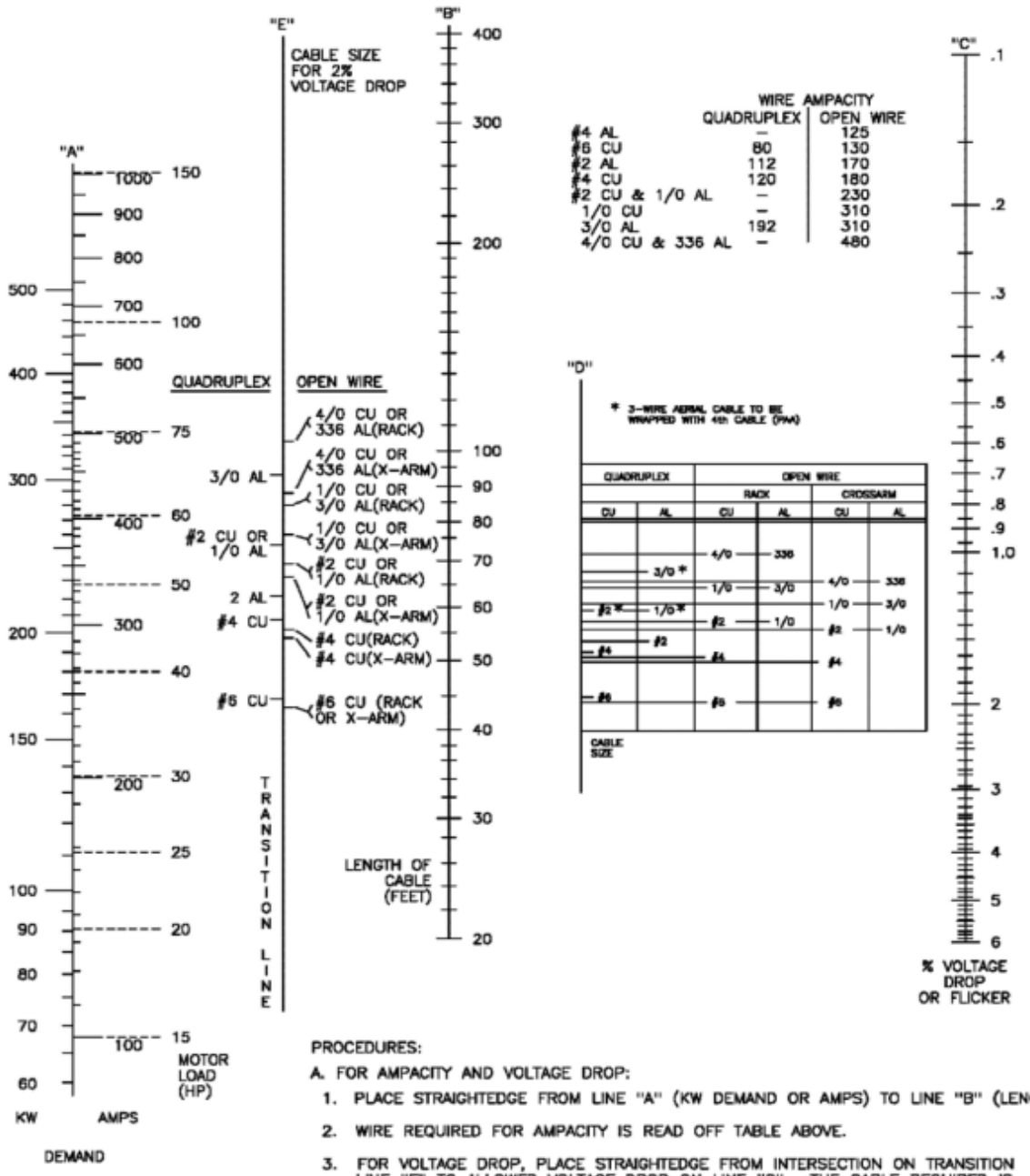

PROCEDURES:

A. FOR AMPACITY AND VOLTAGE DROP:

1. PLACE STRAIGHTEDGE FROM LINE "A" (KW DEMAND OR AMPS) TO LINE "B" (LENGTH OF RUN).
2. WIRE REQUIRED FOR AMPACITY IS READ OFF TABLE ABOVE.
3. FOR VOLTAGE DROP, PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO ALLOWED VOLTAGE DROP ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D".

B. FOR FLICKER:

1. PLACE STRAIGHTEDGE FROM LINE "A" (MOTOR LOAD) TO LINE "B" (LENGTH OF RUN).
2. PLACE STRAIGHTEDGE FROM INTERSECTION ON TRANSITION LINE "E" TO REMAINING ALLOWABLE FLICKER % (TOTAL ALLOW % – TRANSFORMER % = REMAIN ALLOW %) ON LINE "C". THE CABLE REQUIRED IS READ ABOVE STRAIGHTEDGE ON LINE "D"

NOTE: RACK CONSTRUCTION PRODUCES LOWER VOLTAGE DROP THAN CROSS-ARM CONSTRUCTION DUE TO THE SHORTER DISTANCE BETWEEN CONDUCTORS.

SEE GENERAL NOTES ON PAGE 5413.3 IF THE % FLICKER IS GREATER THAN ALLOWABLE LIMITS.

REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C							F						
B							E						
A	5432 MOVED TO FMO	YZZ	FRC	FRC	FRC	11/06/2025	D						

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL FIELD MAINTENANCE ONLY

SHEET 4 OF 4

THREE PHASE 480 OVERHEAD VOLTAGE DROP AND FLICKER NOMOGRAPH

FMO DM5432.4

5500
CONDUCTOR
AMPACITIES

5500
CONDUCTOR
AMPACITIES

5500 - No FMO standards for this section.

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5600 - No FMO standards for this section.

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5700
PADS & SUBSTRUCTURES

5700
PADS & SUBSTRUCTURES

PAGE	SUBJECT
5745	ELECTRIC VAULT DESIGN TABLES FOR SDG&E INTERNAL USE

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REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
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B							E						
A	ORIGINAL ISSUE	YZZ	FRC	FRC	FRC	07/22/2026	D						

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL FIELD MAINTENANCE ONLY

SHEET
1 OF 1

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SUBSTRUCTURES AND CONDUIT

FMO
DM5701.1

DM5745 FIELD MAINTENANCE ONLY

ALL VERSIONS LISTED IN FMO ARE SUPERSEDED BY THEIR CURRENT VERSION FOUND INSIDE THE ELECTRIC DISTRIBUTION DESIGN MANUAL.

REVISION HISTORY:

07/22/2026: DM5745 TABLES MOVED TO FMO

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REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C							F						
B							E						
A	5745 TABLES MOVED TO FMO	YZZ	FRC	FRC	FRC	07/22/2026	D						

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL FIELD MAINTENANCE ONLY

SHEET 1 OF 1

ELECTRIC VAULT DESIGN TABLES FOR SDG&E INTERNAL USE

FMO DM5745

24.6. The following tables apply only to existing or legacy vaults. All new vault installations shall comply with DM5745, which requires a minimum floor-to-ceiling height of 12 feet.

24.6.1. Below grade single transformer vault requirements for 120/208V.

CUST. BOARD	208V TRANSF. SIZE	FRONT TO BACK*	WALL TO WALL	ALONG W/ TRANSF. SWITCH INSTALLED ON SIDE WALL.		ALONG W/ TRANSF. SWITCH INSTALLED ON END WALL		FLOOR TO CEILING	CEILING EQUIPMENT	TRANSF.	SUMP
SIZE	(KVA)	L LENGTH	W WIDTH	L LENGTH	W WIDTH	L LENGTH	W WIDTH	HEIGHT	OPENING	WEIGHT	CAP.
200	75	13′ – 6″	9′ – 6″	NA	NA	NA	NA	8′ – 0″	4′ – 6″ X 6′ – 6″	3,500	240
400	150	13′ – 6″	9′ – 6″	NA	NA	NA	NA	8′ – 0″	4′ – 6″ X 6′ – 6″	3,900	240
600	225	14′ – 0″	9′ – 6″	NA	NA	NA	NA	8′ – 0″	5′ – 0″ X 6′ – 6″	4,200	240
800	300	15′ – 0″	10′ – 6″	NA	NA	NA	NA	8′ – 6″	6′ – 0″ X 7′ – 6″	5,000	255
1000	300	15′ – 0″	10′ – 6″	NA	NA	NA	NA	8′ – 6″	6′ – 0″ X 7′ – 6″	5,000	255
1200	500	16′ – 6″	12′ – 6″	21′ – 6″	15′ – 0″	19′ – 6″	20′ – 9″ *	9′ – 0″	6′ – 6″ X 7′ – 6″	6,600	290
1600	500	16′ – 6″	12′ – 6″	21′ – 6″	15′ – 0″	19′ – 6″	20′ – 0″ *	9′ – 0″	6′ – 6″ X 7′ – 6″	6,600	290
2000	750	17′ – 0″	12′ – 6″	22′ – 6″	15′ – 0″	20′ – 0″	20′ – 0″ *	9′ – 0″	7′ – 0″ X 7′ – 6″	7,550	425
2500	1000	18′ – 0″	13′ – 6″	23′ – 6″	16′ – 6″	21′ – 6″	20′ – 0″ *	10′ – 0″	8′ – 0″ X 7′ – 6″	8,200	435
3000	1000	18′ – 0″	13′ – 6″	23′ – 6″	16′ – 6″	21′ – 6″	20′ – 0″ *	10′ – 0″	8′ – 0″ X 7′ – 6″	8,200	435
4000	1000 1500**	20′ – 0″	16′ – 0″	25′ – 6″	19′ – 0″	23′ – 0″	20′ – 0″	11′ – 0″	10′ – 0″ X 9′ – 0″	10,150	515

24.6.2. Below grade multiple transformer installation 120/208 side by side minimum vault dimensions for multi-services.

LENGTH	13′-6″	13′-6″	14′-0″	15′-0″	15′-0″	16′-6″	16′-6″	17′-0″	18′-0″	18′-0″	20′-0″
-	200i	400i	600i	800i	1000i	1200i	1600i	2000i	2500i	3000i	4000i
WIDTH "A"	9′-6″	9′-6″	9′-6″	10′-6″	10′-6″	12′-6″	12′-6″	12′-6″	13′-6″	13′-6″	16′-0″
WIDTH "B"	7′-6″	7′-6″	7′-6″	8′-6″	8′-6″	9′-6″	9′-6″	9′-6″	10′-6″	10′-6″	12′-0″

WIDTH "A" = Minimum vault requirements for one service panel according to main size
WIDTH "B" = Additional vault requirements for each added service main

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REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C	EDITORIAL CHANGES	YZZ	EJA	MRF	MRF	04/13/2026	F						
B	EDITORIAL CHANGES	YZZ	JES	FRC	JJP	10/31/2025	E						
A	ORIGINAL ISSUE	-	-	-	-	11/20/2018	D	5745 TABLES MOVED TO FMO	YZZ	FRC	FRC	FRC	07/22/2026

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

24.6.3. Below grade minimum electric vault requirements for 277/480V single 3-phase transformer installation.

CUST. BOARD	480V TRANSF. SIZE	FRONT TO BACK*	WALL TO WALL	ALONG W/ TRANSF. SWITCH INSTALLED ON SIDE WALL.		ALONG W/ TRANSF. SWITCH INSTALLED ON END WALL		FLOOR TO CEILING	CEILING EQUIPMENT	TRANSF.	SUMP
SIZE	(KVA)	L LENGTH	W WIDTH	L LENGTH	W WIDTH	L LENGTH	W WIDTH	HEIGHT	OPENING	WEIGHT	CAP.
200	150	13′ – 6″	9′ – 6″	NA	NA	NA	NA	8′ – 0″	4′ – 6″ X 6′ – 6″	3,900	240
400	300	15′ – 0″	10′ – 6″	NA	NA	NA	NA	8′ – 6″	6′ – 0″ X 7′ – 6″	5,000	255
600	500	16′ – 6″	12′ – 6″	21′ – 6″	15′ – 0″	19′ – 6″	20′ – 0″	9′ – 0″	6′ – 6″ X 7′ – 6″	6,600	290
800	500	16′ – 6″	12′ – 6″	21′ – 6″	15′ – 0″	19′ – 6″	20′ – 0″	9′ – 0″	6′ – 6″ X 7′ – 6″	6,600	290
1000	750	17′ – 0″	12′ – 6″	22′ – 6″	15′ – 0″	20′ – 0″	20′ – 0″	9′ – 0″	7′ – 0″ X 7′ – 6″	7,550	425
1200	1000	18′ – 0″	13′ – 6″	23′ – 6″	16′ – 6″	21′ – 6″	20′ – 0″	10′ – 0″	8′ – 0″ X 7′ – 6″	8,200	435
1600	1000	18′ – 0″	13′ – 6″	23′ – 6″	16′ – 6″	21′ – 6″	20′ – 0″	10′ – 0″	8′ – 0″ X 7′ – 6″	8,200	435
2000	1500	20′ – 0″	16′ – 0″	25′ – 6″	19′ – 0″	23′ – 0″	20′ – 0″	11′ – 0″	10′ – 0″ X 9′ – 0″	10,150	515
2500	2000	20′ – 0″	16′ – 6″	25′ – 6″	19′ – 6″	23′ – 0″	20′ – 0″	12′ – 0″	10′ – 0″ X 10′ – 0″	17,300	570
3000	2000	20′ – 0″	16′ – 6″	25′ – 6″	19′ – 6″	23′ – 0″	20′ – 0″	12′ – 0″	10′ – 0″ X 10′ – 0″	17,300	570
4000	2500 3000**	20′ – 0″	16′ – 6″	25′ – 6″	19′ – 6″	23′ – 0″	20′ – 0″	12′ – 0″	10′ – 0″ X 10′ – 0″	17,300	580

24.6.4. Below grade multiple transformer installation 277/480V side by side minimum vault dimensions for multi-services.

LENGTH	13′-6″	15′-0″	16′-6″	16′-6″	11′-0″	12′-0″	18′-0″	20′-0″	20′-0″	20′-0″	20′-0″
-	200i	400i	600i	800i	1000i	1200i	1600i	2000i	2500i	3000i	4000i
WIDTH "A"	9′-6″	10′-6″	12′-6″	12′-6″	12′-6″	13′-6″	16′-0″	16′-6″	16′-6″	16′-6″	16′-6″
WIDTH "B"	7′-6″	8′-6″	9′-6″	9′-6″	9′-6″	10′-6″	10′-6″	12′-0″	12′-6″	12′-6″	12′-6″

WIDTH "A" = Minimum vault requirements for one service panel according to main size
WIDTH "B" = Additional vault requirements for each added service main

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C	EDITORIAL CHANGES	YZZ	EJA	MRF	MRF	04/13/2026	F						
B	EDITORIAL CHANGES	YZZ	JES	FRC	JJP	10/31/2025	E						
A	ORIGINAL ISSUE	-	-	-	-	11/20/2018	D	5745 TABLES MOVED TO FMO	YZZ	FRC	FRC	FRC	07/22/2026

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL FIELD MAINTENANCE ONLY

SDG&E ELECTRIC VAULT REQUIREMENTS AND SPECIFICATIONS

24.6.5. On grade minimum electric vault requirements for 120/208V single 3-phase transformer installation.

CUST. BOARD	208V TRANSF. SIZE	FRONT TO BACK*	WALL TO WALL	ALONG W/ TRANSF. SWITCH INSTALLED ON SIDE WALL		FLOOR TO CEILING	ON GRADE EQUIPMENT OPENING		TRANSF.	SUMP	CLEAR & LEVEL WORKING SPACE IN FRONT OF EQUIPMENT OPENING	
SIZE	(KVA)	L LENGTH	W WIDTH	L LENGTH	W WIDTH	HEIGHT	WIDE	WIDE	WEIGHT	CAP	WIDE	WIDE
200	75	14′ – 6″	9′ – 6″	14′ – 6″	12′ – 6″	8′ – 0″	7′ – 6″	6′ – 6″	3,500	240	6′ – 0″	7′ – 6″
400	150	14′ – 6″	9′ – 6″	14′ – 6″	12′ – 6″	8′ – 0″	7′ – 6″	7′ – 6″	3,900	240	6′ – 0″	7′ – 6″
600	225	16′ – 0″	9′ – 6″	16′ – 0″	12′ – 6″	8′ – 0″	7′ – 6″	7′ – 6″	4,200	240	6′ – 0″	7′ – 6″
800	300	17′ – 0″	10′ – 6″	17′ – 0″	13′ – 6″	8′ – 0″	8′ – 6″	8′ – 6″	5,000	255	7′ – 0″	8′ – 6″
1000	300	17′ – 0″	10′ – 6″	17′ – 0″	13′ – 6″	8′ – 0″	8′ – 6″	8′ – 6″	5,000	255	7′ – 0″	8′ – 6″
1200	500	19′ – 6″	12′ – 6″	19′ – 6″	12′ – 6″	9′ – 0″	8′ – 6″	8′ – 6″	6,600	290	7′ – 0″	8′ – 6″
1600	500	19′ – 6″	12′ – 6″	19′ – 6″	12′ – 6″	9′ – 0″	8′ – 6″	8′ – 6″	6,600	290	7′ – 0″	8′ – 6″
2000	750	20′ – 0″	12′ – 6″	20′ – 0″	15′ – 6″	9′ – 0″	8′ – 6″	8′ – 6″	7,550	425	8′ – 0″	8′ – 6″
2500	1000	21′ – 0″	13′ – 6″	21′ – 0″	16′ – 6″	10′ – 0″	8′ – 6″	8′ – 6″	8,200	435	8′ – 0″	8′ – 6″
3000	1000	21′ – 0″	13′ – 6″	21′ – 0″	16′ – 6″	10′ – 0″	8′ – 6″	8′ – 6″	8,200	435	8′ – 0″	8′ – 6″
4000	100cr... 1500..	23′ – 0″	16′ – 0″	23′ – 0″	19′ – 0″	11′ – 0″	10′ – 0″	10′ – 0″	10,150	515	10′ – 0″	10′ – 0″

24.6.6. On grade multiple transformer installation 120/208V side by side minimum vault dimensions for multi-services.

LENGTH	14′-6″	14′-6″	16′-0″	11′-0″	11′-0″	19′-6″	19′-6″	20′-0″	21′-0″	21′-0″	23′-0″
-	200i	400i	600i	800i	1000i	1200i	1600i	2000i	2500i	3000i	4000i
WIDTH "A"	9′-6″	9′-6″	9′-6″	10′-6″	10′-6″	12′-6″	12′-6″	12′-6″	13′-6″	13′-6″	16′-6″
WIDTH "B"	7′-6″	7′-6″	7′-6″	8′-6″	8′-6″	9′-6″	9′-6″	9′-6″	10′-6″	10′-6″	12′-0″

WIDTH "A" = Minimum vault requirements for one service panel according to main size
WIDTH "B" = Additional vault requirements for each added service main

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C	EDITORIAL CHANGES	YZZ	EJA	MRF	MRF	04/13/2026	F						
B	EDITORIAL CHANGES	YZZ	JES	FRC	JJP	10/31/2025	E						
A	ORIGINAL ISSUE	-	-	-	-	11/20/2018	D	5745 TABLES MOVED TO FMO	YZZ	FRC	FRC	FRC	07/22/2026

24.6.7. On grade minimum electric vault requirements for 277/480V single 3-phase transformer installation.

CUST. BOARD	480V TRANSF. SIZE	FRONT TO BACK*	WALL TO WALL	ALONG W/ TRANSF. SWITCH INSTALLED ON SIDE WALL		FLOOR TO CEILING	ON GRADE EQUIPMENT OPENING		TRANSF.	SUMP	CLEAR & LEVEL WORKING SPACE IN FRONT OF EQUIPMENT OPENING	
SIZE	(KVA)	L LENGTH	W WIDTH	L LENGTH	W WIDTH	HEIGHT	WIDE	WIDE	WEIGHT	CAP	WIDE	WIDE
200	150	14′ – 6″	9′ – 6″	14′ – 6″	12′ – 6″	8′ – 0″	7′ – 6″	7′ – 6″	3,900	240	6′ – 0″	7′ – 7″
400	300	11′ – 0″	10′ – 6″	17′ – 0″	13′ – 6″	8′ – 6″	8′ – 0″	8′ – 6″	5,000	255	7′ – 0″	8′ – 6″
600	500	19′ – 6″	12′ – 6″	19′ – 6″	15′ – 6″	9′ – 0″	8′ – 6″	8′ – 6″	6,600	290	7′ – 0″	8′ – 6″
800	500	19′ – 6″	12′ – 6″	19′ – 6″	15′ – 6″	9′ – 0″	8′ – 6″	8′ – 6″	6,600	290	7′ – 0″	8′ – 6″
1000	750	12′ – 0″	12′ – 6″	20′ – 0″	15′ – 6″	9′ – 0″	8′ – 6″	8′ – 6″	7,500	425	8′ – 0″	8′ – 6″
1200	1000	21′ – 0″	13′ – 6″	21′ – 0″	16′ – 6″	10′ – 0″	8′ – 6″	8′ – 6″	8,200	435	8′ – 0″	8′ – 6″
1600	1000	21′ – 0″	13′ – 6″	21′ – 0″	16′ – 6″	10′ – 0″	8′ – 6″	8′ – 6″	8,200	435	8′ – 0″	8′ – 6″
2000	1500	23′ – 0″	16′ – 0″	23′ – 0″	19′ – 0″	11′ – 0″	10′ – 0″	10′ – 0″	10,150	515	10′ – 0″	10′ – 0″
2500	2000	23′ – 0″	16′ – 6″	23′ – 0″	19′ – 6″	12′ – 0″	10′ – 0″	10′ – 0″	17,300	570	10′ – 0″	10′ – 0″
3000	2000	23′ – 0″	16′ – 6″	23′ – 0″	19′ – 6″	12′ – 0″	10′ – 6″	10′ – 0″	17,300	570	10′ – 0″	10′ – 0″
4000	2500 3000*	23′ – 0″	16′ – 6″	23′ – 0″	19′ – 6″	12′ – 0″	10′ – 6″	10′ – 0″	17,300	580	10′ – 0″	10′ – 0″

24.6.8. On grade multiple transformer installation 277/480V side by side minimum vault dimensions for multi-services.

LENGTH	14′-6″	11′-0″	19′-6″	19′-6″	20′-0″	21′-0″	21′-0″	23′-0″	23′-0″	23′-0″	23′-0″
-	200i	400i	600i	800i	1000i	1200i	1600i	2000i	2500i	3000i	4000i
WIDTH "A"	9′-6″	10′-6″	12′-6″	12′-6″	12′-6″	13′-6″	16′-0″	16′-6″	16′-6″	16′-6″	16′-6″
WIDTH "B"	7′-6″	8′-6″	9′-6″	9′-6″	9′-6″	10′-6″	10′-6″	12′-0″	12′-6″	12′-6″	12′-6″

WIDTH "A" = Minimum vault requirements for one service panel according to main size
WIDTH "B" = Additional vault requirements for each added service main

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C	EDITORIAL CHANGES	YZZ	EJA	MRF	MRF	04/13/2026	F						
B	EDITORIAL CHANGES	YZZ	JES	FRC	JJP	10/31/2025	E						
A	ORIGINAL ISSUE	-	-	-	-	11/20/2018	D	5745 TABLES MOVED TO FMO	YZZ	FRC	FRC	FRC	07/22/2026

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5800
CAPACITORS

5800
CAPACITORS

5800 - No FMO standards for this section.

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5900
WIRE & SUPPORTS

5900
WIRE & SUPPORTS

PAGE	SUBJECT
5931	DETERMINING GUY REQUIREMENTS WITH THE GUY COMPUTER

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C							F						
B							E						
A	ORIGINAL ISSUE	YZZ	LY	FRC	FRC	08/18/2026	D						

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DM5931 FIELD MAINTENANCE ONLY

ALL VERSIONS LISTED IN FMO ARE SUPERSEDED BY THEIR CURRENT VERSION FOUND INSIDE THE ELECTRIC DISTRIBUTION DESIGN MANUAL.

REVISION HISTORY:

08/18/2026: MOVED TO FMO. DESIGN IS DONE IN PLS-CADD AND O-CALC. THE CALCULATOR IS NO LONGER USED.

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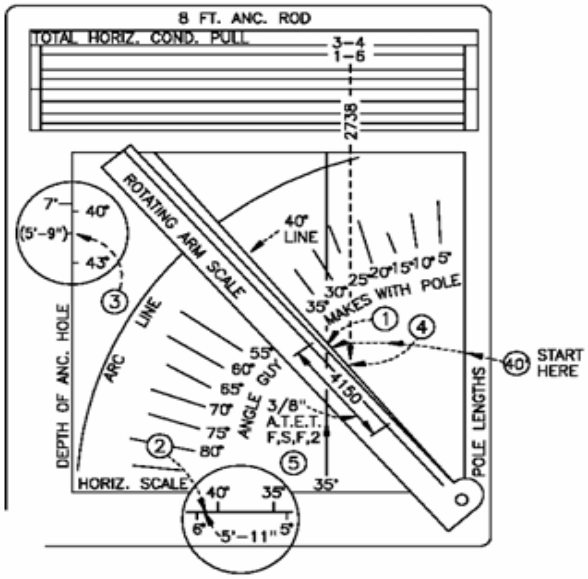
C							F						
B							E						
A	ORIGINAL ISSUE	YZZ	LY	FRC	FRC	08/18/2026	D						

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

HOW TO USE THE GUY COMPUTER

NOTE: In using rotating arm scale, all readings are perpendicular to the upper scale edge.



EXAMPLE NO. 1

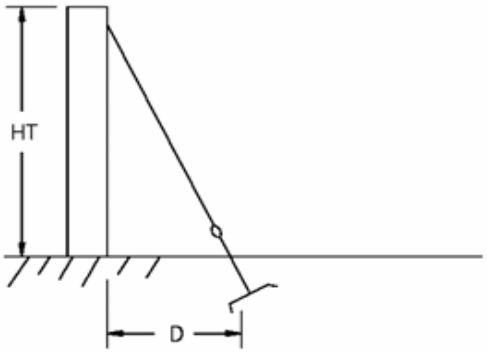
Example No. 1

To Determine

1. Angle which guy makes with pole
2. Point where anchor rod enters ground
3. Depth of anchor hole
4. Tension on guy wire
5. Size of guy wire, using a factor safety of 2.

Given

Pole Attachment (HT)	40 ft.
Horizontal distance, anchor hole to pole (D)	35 ft.
Length of anchor rod	8 ft.
Number and size of conductors at top circuit position	3 – #4 and 1–#6 B. Str. H.D.



Solution

1. Use 8 ft. anchor rod chart. Find 35' mark on the Horizontal Distance scale at bottom of chart; project a line vertically from this mark to where it intersects with curve line marked 40'. Rotate scale arm so that upper edge coincides with intersection. Read 41° – on angle scale, which is the angle that the Guy makes with Pole.

2. On the horizontal scale at bottom of page titled "Anchor Hole to Beginning of Anchor Rod Slot" find 41°–mark. By interpolation it will be found that this distance is approximately 5'11".

3. The depth of anchor hole can be found in a similar manner on the vertical scale at the left side of the chart, answer – 6'9".

4. On the conductor tensions at the top of the chart in the section titled "Hard Drawn Bare Stranded" and on the line containing 4 wire combinations, find 3 – #4 and 1–#6. Follow this dashed line to where it intersects scale arm resting on 41° –diagonal. Read 4150# at intersection point on top scale of arm.

5. Inspection will show this tension falls within the 3/8" A.T. & T. band on the third line of the arm scale.

REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C							F						
B	5931 MOVED TO FMO	YZZ	LY	FRC	FRC	08/18/2026	E						
A	REVISION	-	-	-	CVN	01/01/1987	D						

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DETERMINING GUY REQUIREMENTS WITH THE GUY COMPUTER

FMO DM5931.1

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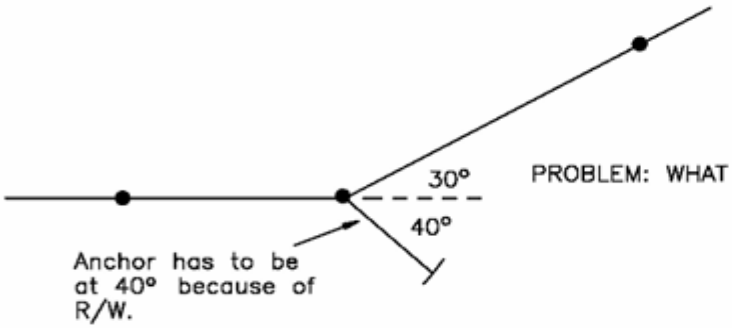
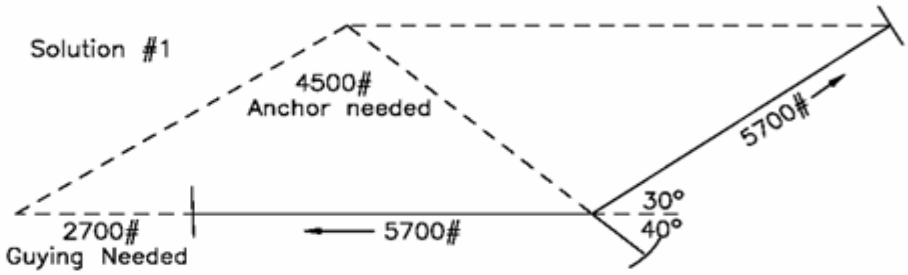
VECTORING



PROBLEM: WHAT SIZE ANCHOR AND GUYING?



When using rotating arm scale, all readings are perpendicular to the upper scale edge.

Example No. 2

To Determine

1. Resultant Tension or Pull when anchor is to be installed on the bisection of angle in the line.
2. Angle which guy makes with pole.
3. Tension on guy wire.
4. Size of guy wire, using a factor safety of 2.

Given

Length of pole..... 45 ft.
Horizontal Distance anchor hole to pole..... 37 ft.
Length of anchor rod..... 10 ft.
Number of conductors at top circuit position . 3–#1/0 and 1 – #2 B. Str. H.D.
Angle of departure of line..... 24°

Solution

1. Use 10 ft anchor chart. Under the title "Total Horizontal Conductor Pull" at top of chart in Hard Drawn Bare Stranded section on the line containing 4 wire combinations, find 3 – #1/0 and 1– #2. Follow this dashed line to where it intersects the arc line. Rotate scale arm to where upper edge coincides with this intersection. Find 24° on 2nd line of rotating scale. Mark this point at upper scale edge. Swing scale to horizontal positions. Project a line from point vertically downward to scale, read 2900#, which is the total horizontal pull.

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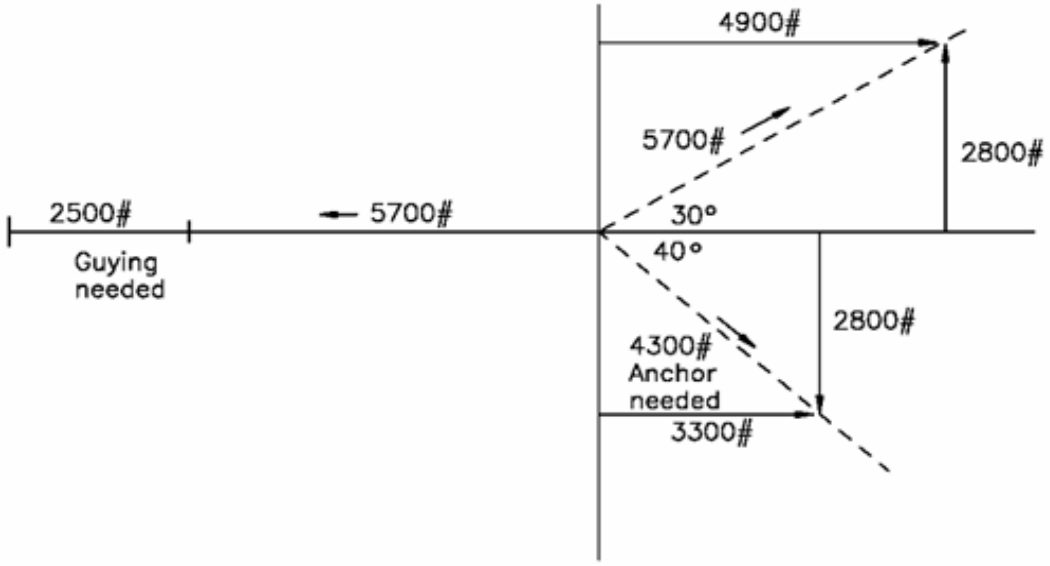
2. Find guy angle by method described in previous problem, answer – 39°.

3. Set scale arm on 39° . Read tension on scale where previously projected 2900# line intersects 39° line, answer – 4600#

4. The 4600# guy tension falls within the band marked for 3/8" A.T. & T.

If the guy angle has not previously been determined and it is desired to make the most of shortened "lead" distance and maximum use of any indicated size of guy wire, this can be accomplished by the following operation. Rotate the scale arm to where 5750# (maximum safe tension for 3/8" A.T.&T.) on scale arm coincides with previously projected 2900# line. The scale arm will reset on the 31° angle. Find intersection of pole height curve line for 45' pole and follow vertically downward to Horizontal Distance scale, read 27'. Similarly follow through for 7/16" A.T. & T (9000# max.) Answers–19° and 16'. Inspection will show that 5/16" A. T. & T. is applicable in this case only to an angle such as those produced by head guys.

Solution #2



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DETERMINING GUY REQUIREMENTS WITH THE GUY COMPUTER

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6000
SUBSTATION
LOAD FORCASTING

6000 - No FMO standards for this section.

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A	6114 MOVED TO FMO	JIK	MAK	FRC	KRG	09/16/2024	D						

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SECTIONALIZING AND PROTECTION

DM6114 FIELD MAINTENANCE ONLY

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REVISION HISTORY:

09/16/2024: MOVED TO FMO

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SCOPE

This document provides criteria for the selection and application of 12KV feeder sectionalizing devices on selected high–risk circuits.

PURPOSE

Application of automatic sectionalizing devices for underground circuits (pad–mounted service restorer and PME3 with SCADA) can be beneficial in reducing the number of customers affected by service interruptions. These devices are also helpful in reducing the projected SAIDI by minimzing the impact of a failure of the unfused high molecular polyethylene (HMWPE or PECN in GFMS or unjacketed cross–linked polyethylene (XLPE) cable.

CRITERIA

A. Circuits chosen for study should meet one or more of the following:

1. A high amount of unfused type HMWPE of XLPE cable as defined by
   a. Total cable length exceeding one mile or
   b. Exceeding 20 percent of the total underground cable length
2. Underground outage history exceeding three feeder outages over the last three years regardless of cause.

B. In addition to the above, the application must be prioritized based on the cost–to–benefit (C/B) ratio analysis in Design Manual section 6145. The projected value (the inverse of the C/B ratio) must be greater than one to justify the additional sectionalizing devices. Alternate methods of project methods of project justification may be allowed by Electric Distribution Planning.

APPLICATION

The circuit under consideration must be examined to ensure that it will meet the switching provisions of Design Manual section 6111 after modification. Service restorers are the preferred device because of the automatic operation and the fact that they can immediately reduce the number of customers affected by an outage. If a service restorer is already in use on a circuit, the PME3 with SCADA should be used where substation SCADA is available or will be available within two years. In cases where the frequency is not as critical, the PME3 with SCADA may be the most economical choice.

1. 600A Padmounted Service Restorer

a. Consideration must be made regarding the location and length of the un–fused cable segments when locating the service restorer. As a general guide, locate the service to maximize the amount of load on the line side of the device and to maximize the circuit length on load side. The service restorer should be located to protect at least one half of the circuit load. If this is not practical, locate to maximize the isolation of the unfused cable sections.

b. A line switch is required immediately ahead of the service restorer for maintenance. This may be an overhead gang operated or hookstick switch, a padmount switch, a handhole switch (On–Off),or a manhole switch (group/On–Off). Manhole switches are acceptable for this application but they are not preferred.

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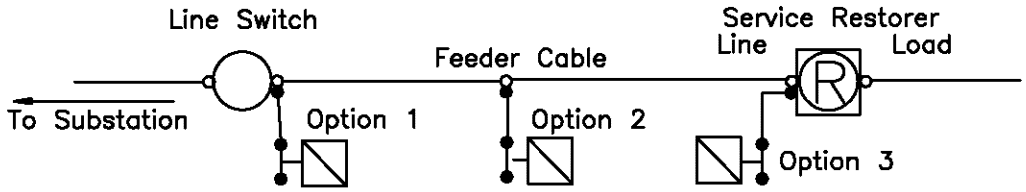
APPLICATION (continued)

c. No load should be connected between the service restorer and the line switch immediately ahead. An exception to this rule would be the placement of a single phase transformer that would only provide secondary service for the actuator device within the service restorer. This single phase transformer may tap the feeder at either the switch, the service restorer or in between. Following is an illustrative one-line diagram for the three optional hookups.



Special Note: DM 6121.3.d.1 requires that a fuse request be submitted and approved prior to installation of un-fused transformer stations.

d. If the service restorer is located so as to protect a purely underground section it shall be set for one test reclosing 5 seconds after the fault, then lockout. Distribution Planning will determine the number of test reclosings for circuits with overhead spans on the load side of the service restorer.

e. Distribution Planning must be contacted to obtain settings for all protective devices on the circuit.

2. PME3 with SCADA or SCADA Overhead Switch

The PME3 with SCADA should be applied in cases where: 1) A feeder has an existing service restorer and protection (fuse) coordination is not possible. 2) The less expensive SCADA switch will provide adequate protection for the circuit being studied.

a. If existing subsurface or padmount switchgear is strategically placed for service restoration contact Electric Distribution Standards about SCADA actuator retro-fit. This option can be more economical than other options.

b. Install SCADA type switches at the midpoint, one-quarter and three-quarter points on the feeder in that order of preference. These may be the new PME3 SCADA switch, SCADA overhead switch, or an existing underground switch retro-fitted with SCADA.

c. SCADA operated devices may be installed on feeders from current non-SCADA substations where SCADA is not planned within two years. Substations where SCADA is not planned within two years will limit options to automatic protection devices.

d. Consideration should be given to converting strong tie switches to SCADA.

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REVISION HISTORY:

04/20/2026: MOVED TO FMO

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RELAY AND FUSE COORDINATION TABLES

FMO DM6134.1

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MINIMUM LINE-TO-GROUND FAULT CURRENT REQUIRED FOR COORDINATION

Relay Type		KEARNY QA				FUSE S&C SM-4				TYPE/SIZE EOD/SD EJO-1				KB		RTE	FE
	75	100	125	150	200	65	80	100	125	150	200	80	100	150	200	80	150	150	30
CO-8																			
1	*	1950	3300	4800	8400	*	2100	3300	5100	6600	8400	*	1050	2700	3900	750	2850	3900	*
2	*	*	1350	2730	5400	*	*	1200	2700	3900	4800	*	900	2040	2910	*	2070	2460	*
3	*	*	*	1800	3900	*	*	*	1590	2550	3450	*	*	1830	2670	*	1770	2100	*
4	*	*	*	1500	3300	*	*	*	1260	1860	2820	*	*	1770	2490	*	1350	1650	*
5	*	*	*	1260	2700	*	*	*	1110	1560	2460	*	*	1710	2400	*	1320	1290	*
IAC53																			
1	1350	2640	3750	5250	9000	660	2700	3900	5700	7200	8700	675	1200	3000	4200	900	3300	4200	700
2	*	*	2250	3750	6750	*	750	2100	3300	4800	6300	*	960	2250	3300	*	2160	3600	*
3	*	*	1110	2700	5400	*	*	1140	2700	3900	5100	*	900	2040	2850	*	1800	2400	*
4	*	*	900	2100	4500	*	*	900	1920	3300	4200	*	840	1890	2700	*	1560	2100	*
5	*	*	*	1500	3900	*	*	840	1350	2350	3450	*	*	1800	2550	*	1350	1800	*
CO 1																			
1	*	*	2100	3750	6600	*	810	2100	3600	4800	5850	*	*	2250	3300	*	2160	3300	*
2	*	*	840	2100	4500	*	*	840	1980	3000	4500	*	*	1950	2700	*	1620	2100	*
3	*	*	*	1350	3750	*	*	*	1290	2100	3300	*	*	1800	2550	*	1350	1650	*
4	*	*	*	1230	3000	*	*	*	1140	1680	2700	*	*	1740	2400	*	1290	1500	*
5	*	*	*	1200	2550	*	*	*	1050	1500	2340	*	*	1650	2370	*	1260	1350	*
CO-AI																			
1	*	2400	5400	7200	11700	*	2100	3300	4800	6300	7500	720	1200	3000	3900	900	3300	4200	700
2	*	*	2100	3000	5100	*	*	1380	2700	3900	4800	*	990	2250	3030	*	2400	3300	*
3	*	*	1050	2100	4500	*	*	*	1650	2700	3600	*	900	2010	2730	*	1950	2230	*
4	*	*	*	1680	3600	*	*	*	1320	2040	2850	*	*	1860	2640	*	1740	1950	*
5	*	*	*	1350	2800	*	*	*	1140	1650	2400	*	*	1800	2460	*	1500	1750	*
IAC51																			
1	1500	2100	3000	4050	6600	1560	2100	3000	3900	4800	6000	900	1350	2750	3600	1250	3000	3600	900
2	1050	1500	2100	2700	4650	960	1380	1800	2490	3600	4050	800	1125	2250	3000	1000	2400	2700	750
3	650	1125	1650	2250	4050	660	990	1350	2030	2700	3150	750	1050	2000	2700	800	2100	2400	600
4	*	975	1350	1900	3600	*	840	1110	1710	2100	2700	680	1000	1900	2600	750	1800	2100	*
5	*	840	1200	1750	3000	*	750	1020	1500	2010	2550	675	975	1800	2500	675	1650	1900	*
IT >	1250	1500	2000	2500	3750	1300	1600	2000	2500	3100	3700	650	800	1500	1800	800	1700	2000	550

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Relay Type	KEARNY QA				FUSE TYPE/SIZE S&C SM-4					EOD/SD EJO-1			KB		RTE		FE
	75	100	125	150	200	65	80	100	125	150	200	80	100	150	80	150	150	200	30
CO-8 1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2	*	*	2100	1500	1200	*	*	*	1140	1050	1800	*	*	1740	*	1290	1350	1800	*
3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
4	*	*	1200	1200	1200	*	*	*	1410	1410	1410	*	*	1650	*	*	*	*	*
5	*	*	*	*	*	*	*	*	*	*	*	*	*	1530	*	*	*	*	*
IAC53 1	*	1350	3300	4800	8400	*	*	2520	4500	6000	7800	*	900	2670	3750	2700	3750	3750	*
2	*	*	*	2700	6000	*	*	*	1200	3600	5400	*	*	1980	2850	1560	2340	2340	*
3	*	*	*	1500	5100	*	*	*	1050	1500	3600	*	*	1830	2670	1380	1800	1800	*
4	*	*	*	1275	4200	*	*	*	*	1400	2550	*	*	1800	2460	1320	1650	1650	*
5	*	*	*	*	3000	*	*	*	*	1320	2190	*	*	1710	2400	1260	1290	1290	*
CO 1 1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2	*	*	2460	1200	4200	*	*	*	1320	3300	5100	*	*	1980	2940	1560	2250	2250	*
3	*	*	*	*	2700	*	*	*	*	1380	2850	*	*	1770	2550	1290	1500	1500	*
4	*	*	*	*	2100	*	*	*	*	1320	2040	*	*	1650	2400	1260	1275	1275	*
5	*	*	1890	*	*	*	*	*	*	*	1920	*	*	1560	2280	*	*	*	*
CO-A1 1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2	*	*	*	*	*	*	*	3300	5400	6600	*	*	*	2310	3300	2430	3300	3300	*
3	*	*	*	*	*	*	*	*	2250	3600	*	*	*	1830	2700	1500	1950	1950	*
4	*	*	*	*	*	*	*	*	1350	2200	*	*	*	1725	2430	*	1330	1330	*
5	*	*	1950	*	*	*	*	*	*	1950	1770	*	*	2590	2370	*	*	*	*
IAC51 1	*	*	*	*	*	*	*	*	*	*	*	*	1200	2400	3150	2700	3200	3200	*
2	*	*	*	*	*	1500	2100	3300	4200	5400	*	*	1050	2100	2750	2100	2400	2400	*
3	*	*	*	*	*	*	1200	2100	2760	3600	*	*	1000	1950	2675	1800	2000	2000	*
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IT >	1250	1500	2000	2500	3750	1300	1600	2000	2500	3100	3700	650	800	1500	1800	800	1700	2000	550

REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
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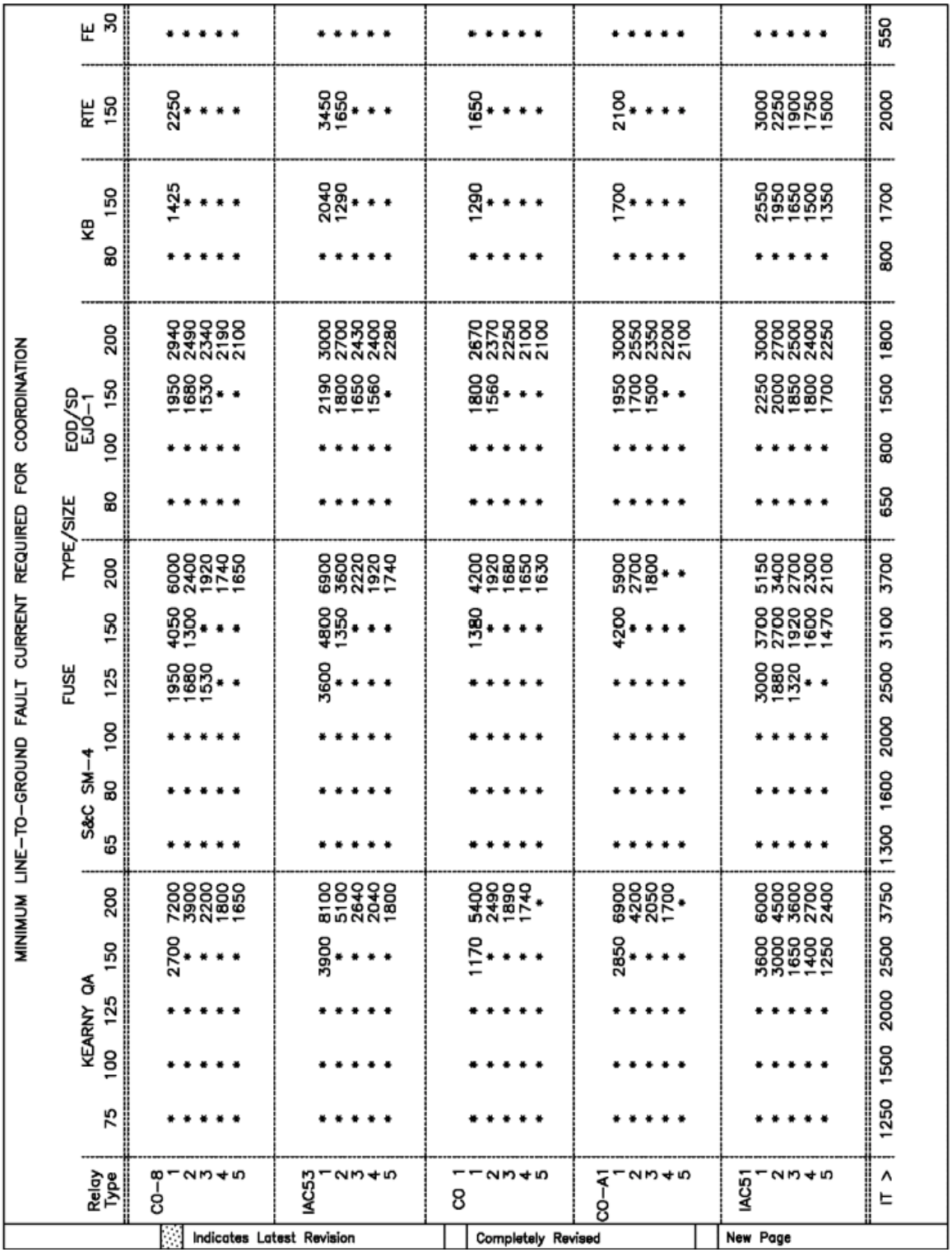

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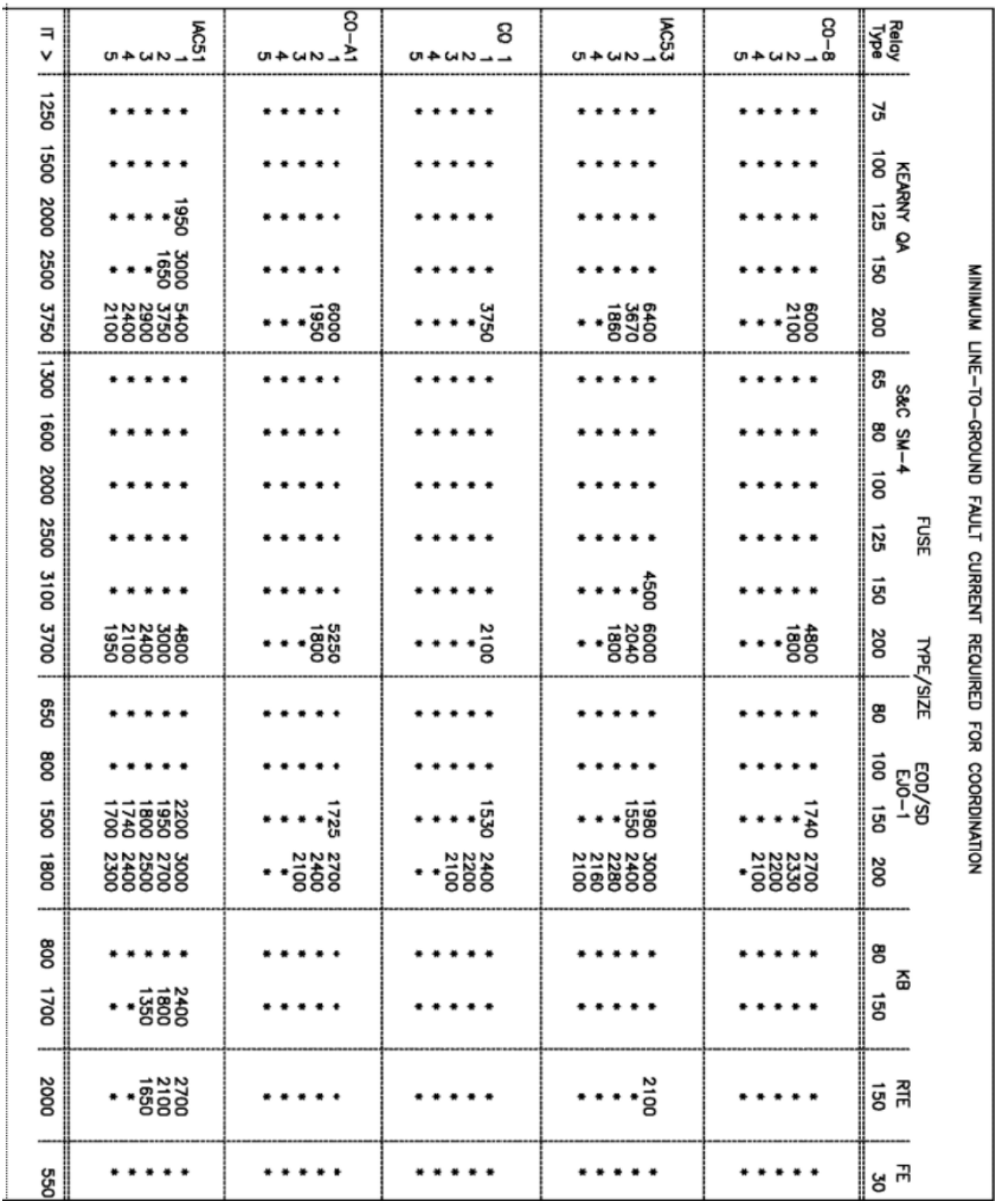

MINIMUM LINE-TO-GROUND FAULT CURRENT REQUIRED FOR COORDINATION

Relay Type	KEARNY QA FUSE TYPE/SIZE 75	100	125	150	200	S&C SM-4 FUSE TYPE/SIZE 65	80	100	125	150	200	EOD/SD EJO-1 TYPE/SIZE 80	100	150	200	KB 80	150	RTE 150	FE 30
CO-8 1	*	*	*	*	6000	*	*	*	*	*	4800	*	*	1740	2700	*	*	*	*
CO-8 2	*	*	*	*	2100	*	*	*	*	*	1800	*	*	*	2330	*	*	*	*
CO-8 3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2200	*	*	*	*
CO-8 4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2100	*	*	*	*
CO-8 5	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
IAC53 1	*	*	*	*	6400	*	*	*	*	4500	6000	*	*	1980	3000	*	*	*	*
IAC53 2	*	*	*	*	3670	*	*	*	*	*	2040	*	*	1550	2400	*	*	*	*
IAC53 3	*	*	*	*	1860	*	*	*	*	*	1800	*	*	*	2280	*	*	*	*
IAC53 4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2160	*	*	*	*
IAC53 5	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2100	*	*	*	*
CO 1 1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
CO 1 2	*	*	*	*	3750	*	*	*	*	*	2100	*	*	1530	2400	*	*	*	*
CO 1 3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2200	*	*	*	*
CO 1 4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2100	*	*	*	*
CO 1 5	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
CO-A1 1	*	*	*	*	6000	*	*	*	*	5250	4800	*	*	1725	2700	*	*	*	*
CO-A1 2	*	*	*	*	1950	*	*	*	*	1800	3000	*	*	*	2400	*	*	*	*
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CO-A1 4	*	*	*	*	*	*	*	*	*	*	2100	*	*	1740	2400	*	*	*	*
CO-A1 5	*	*	*	*	*	*	*	*	*	*	1950	*	*	1700	2300	*	*	*	*
IAC51 1	*	*	*	*	5400	*	*	*	*	*	4800	*	*	2200	3000	*	*	*	*
IAC51 2	*	*	*	*	3750	*	*	*	*	*	3000	*	*	1950	2700	*	*	*	*
IAC51 3	*	*	*	*	2900	*	*	*	*	*	2400	*	*	1800	2500	*	*	*	*
IAC51 4	*	*	*	*	2400	*	*	*	*	*	2100	*	*	1740	2400	*	*	*	*
IAC51 5	*	*	*	*	2100	*	*	*	*	*	1950	*	*	1700	2300	*	*	*	*
IT >	1250	1500	2000	2500	3750	1300	1600	2000	2500	3100	3700	650	800	1500	1800	800	1700	2000	550

REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
C							F						
B	6134 MOVED TO FMO	YZZ	DJB	FRC	FRC	04/20/2026	E						
A	REVISION	-	-	-	JCE	01/01/2000	D						

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RELAY AND FUSE COORDINATION TABLES

FMO DM6134.4

DM6136 FIELD MAINTENANCE ONLY

ALL VERSIONS LISTED IN FMO ARE SUPERSEDED BY THEIR CURRENT VERSION FOUND INSIDE THE ELECTRIC DISTRIBUTION DESIGN MANUAL.

REVISION HISTORY:

07/14/2026: MOVED TO FMO

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A	6136 MOVED TO FMO	YZZ	MOV	FRC	FRC	07/14/2026	D						

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SERVICE RESTORER/FUSE COORDINATION TABLE

FMO DM6136.1

SCOPE: This standard shows the minimum line to ground fault current required for safe coodination between service restorers and fuses.

Service Restorer Ground Setting	Slow Curve	Fuse Type/Size QA 15	20	25	30	40	50	60	75	100	125	150	200	Kearney Type B 30	80	150
14	18	125	300	400	525	675	875	1050	1500	1975	2725	3300	4800	750	1250	2700
14	14	250	425	450	575	750	925	1200	1550	2100	2700	3250	5100	825	1350	2700
14	8	450	600	750	900	1150	1550	1750	2400	3000	3900	4800	7500	850	1800	3600
14	3	125	225	275	375	525	625	825	1125	1500	1800	2400	3750	700	1050	2100
14	2	175	300	400	525	650	825	1050	1350	1800	2400	3000	4500	725	1200	2475
14	K	300	1500	1800	2250	2700	3200	4400	6000	7600	10000	12000	18000	1050	2550	5400
70	18	*	*	*	*	225	325	450	1050	1725	2325	3000	4650	600	1050	2550
70	14	*	*	*	225	450	750	975	1450	1950	2475	3150	5100	725	1200	2650
70	8	*	*	*	600	975	1275	1550	2400	3000	3900	4800	7500	650	1500	3000
70	3	*	*	*	*	250	375	450	750	1175	1575	2175	3750	550	900	1950
70	2	*	*	*	*	275	400	550	1075	1575	2175	2925	4500	600	1050	2400
70	K	*	*	*	*	*	*	*	1800	4500	10000	12000	18000	550	1050	4500
100	18	*	*	*	*	*	*	325	525	1050	2000	2700	4500	525	750	2325
100	14	*	*	*	*	*	425	750	1350	1825	2425	3100	5100	700	1150	2625
100	8	*	*	*	*	600	1050	1425	2250	3000	3900	4800	7500	750	1650	3600
100	3	*	*	*	*	*	*	375	600	900	1350	1950	3600	525	750	1850
100	2	*	*	*	*	*	300	425	750	1350	1900	2700	4500	575	875	2250
100	K	*	*	*	*	*	*	*	*	600	5200	9000	18000	*	650	3300
140	18	*	*	*	*	*	275	375	600	1350	2100	2850	4500	450	650	2050
140	14	*	*	*	*	*	*	425	1150	1725	2400	3000	5100	600	1050	2500
140	8	*	*	*	*	*	450	1200	2100	3000	3900	4800	7500	700	1500	3600
140	3	*	*	*	*	*	*	*	475	750	1050	1775	3300	*	450	1350
140	2	*	*	*	*	*	*	*	550	900	1500	2400	4500	400	725	2100
140	K	*	*	*	*	*	*	*	*	*	825	4200	19500	525	675	2250
170	18	*	*	*	*	*	*	*	*	600	900	1800	4500	*	600	1650
170	14	*	*	*	*	*	*	*	750	1500	2100	3000	4900	550	900	2400
170	8	*	*	*	*	*	*	750	1350	2700	3750	4800	7500	675	1250	3300
170	3	*	*	*	*	*	*	*	*	675	925	1500	2800	*	600	1500
170	2	*	*	*	*	*	*	*	*	725	1075	2050	4450	*	675	1800
170	K	*	*	*	*	*	*	*	*	*	*	1200	13500	*	*	1350
200	18	*	*	*	*	*	*	*	*	*	775	1350	4200	*	*	1500
200	14	*	*	*	*	*	*	*	*	1200	2050	2725	4600	*	750	2350
200	8	*	*	*	*	*	*	*	1500	2550	3650	4500	7500	600	1350	3300
200	3	*	*	*	*	*	*	*	*	600	850	1350	2700	*	600	1400
200	2	*	*	*	*	*	*	*	*	600	900	1725	4200	*	650	1725
200	K	*	*	*	*	*	*	*	*	*	*	1050	8500	*	*	1425
240	18	*	*	*	*	*	*	*	*	*	*	1200	3400	*	*	1425
240	14	*	*	*	*	*	*	*	*	750	1725	2700	4600	*	*	2200
240	8	*	*	*	*	*	*	*	*	2100	3300	4500	7500	*	950	3200
240	3	*	*	*	*	*	*	*	*	*	750	1250	2600	*	*	1350
240	2	*	*	*	*	*	*	*	*	*	825	1350	3900	*	*	1500
240	K	*	*	*	*	*	*	*	*	*	*	*	6000	*	*	*
280	18	*	*	*	*	*	*	*	*	*	*	1050	2300	*	*	1275
280	14	*	*	*	*	*	*	*	*	*	1200	2400	4500	*	*	2100
280	8	*	*	*	*	*	*	*	*	1700	3000	4200	7500	*	*	3000
280	3	*	*	*	*	*	*	*	*	*	*	1150	2100	*	*	1300
280	2	*	*	*	*	*	*	*	*	*	*	1225	3000	*	*	1350
280	K	*	*	*	*	*	*	*	*	*	*	*	1500	*	*	*

NOTES:

* Will coordinate for all fault current values.

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C							F						
B	6136 MOVED TO FMO	YZZ	MOV	FRC	FRC	07/14/2026	E						
A	REVISION	-	-	-	JCE	01/01/2000	D						

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SERVICE RESTORER/FUSE COORDINATION TABLE

FMO DM6136.1

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Service Restorer Ground Slow Setting	Curve	Fuse type/size															
		EOD/SD EJO–1					RTE	S&C SM–4									
		40	80	100	125	150	150	25	30	40	50	65	80	100	125	150	200
14	18	375	1000	1350	2000	2400	3100	600	720	900	1100	1500	1800	2400	3000	3800	4800
14	14	425	1050	1375	2100	2500	3150	625	750	975	1200	1625	2100	2550	3300	3900	5100
14	8	575	1350	1800	2700	3200	4350	1050	1275	1500	1825	2550	3000	3900	5100	6000	8100
14	3	375	875	1200	1650	2100	2350	400	475	625	725	1050	1350	1675	2100	2600	3300
14	2	375	975	1300	1850	2300	2800	550	750	800	1000	1400	1650	2100	2750	3300	4200
14	K	575	3000	3900	5700	6600	8400	4200	5100	6000	6600	8700	10500	12500	16500	19200	30000
70	18	325	775	1200	1800	2350	2850	*	*	300	450	650	1450	2025	2750	3600	4600
70	14	350	975	1300	1950	2400	3000	225	450	675	975	1500	1800	2325	3000	3900	4800
70	8	270	870	1320	1890	2400	4500	750	1050	1350	1750	2400	3000	3800	5100	6000	7800
70	3	325	750	1050	1500	2000	2250	*	225	300	450	725	1000	1400	1900	2400	3300
70	2	350	800	1175	1750	2250	2700	*	225	325	525	1000	1425	1900	2700	3450	4200
70	K	*	750	1200	2600	3900	7500	*	*	*	375	975	4200	10500	14100	16800	30000
100	18	*	700	1050	1650	2250	2700	*	*	*	375	550	800	1650	2575	3300	4500
100	14	350	900	1275	1950	2400	3000	*	*	375	775	1350	1775	2175	3000	3900	4800
100	8	375	1200	1775	2700	3400	4400	*	700	1175	1575	2400	3000	3800	5100	6000	7800
100	3	300	725	1050	1500	1950	2100	*	*	*	375	575	775	1075	1675	2225	3000
100	2	300	750	1075	1650	2150	2650	*	*	*	400	700	1050	1650	2500	3200	4200
100	K	*	675	1325	1800	2800	4900	*	*	*	*	*	650	3300	12600	16800	29400
140	18	*	675	950	1475	2075	2400	*	*	*	*	475	675	850	1800	2850	3900
140	14	*	825	1200	1800	2400	3000	*	*	*	425	1050	1500	2100	3000	3600	4800
140	8	*	1025	1500	2400	3300	4250	*	*	*	1150	2100	2800	3600	4800	6000	7800
140	3	*	510	800	1150	1500	1950	*	*	*	*	525	700	900	1350	1950	2700
140	2	*	700	1025	1500	2050	2400	*	*	*	*	600	725	1100	2000	2850	3900
140	K	*	*	825	1350	2100	3000	*	*	*	*	*	*	725	2550	6250	29400
170	18	*	600	900	2700	3700	2100	*	*	*	*	*	600	810	1250	2250	3600
170	14	*	750	1150	1700	2300	2850	*	*	*	*	700	1275	1925	2825	3600	4500
170	8	*	875	1425	2400	3050	4250	*	*	*	550	1950	2550	3600	4800	6000	7800
170	3	*	675	900	1300	1800	1800	*	*	*	*	*	625	775	1225	1600	2400
170	2	*	700	950	1400	1900	2100	*	*	*	*	*	700	900	1650	2400	3600
170	K	*	*	*	1200	1800	2100	*	*	*	*	*	*	*	1050	3300	29400
200	18	*	*	925	1950	3600	1800	*	*	*	*	*	*	750	1100	1550	3000
200	14	*	725	1050	1650	2150	2700	*	*	*	*	*	900	1725	2700	3500	4200
200	8	*	825	1300	2250	3000	4200	*	*	*	*	1500	2400	3300	4800	6000	7800
200	3	*	*	700	1000	1325	1650	*	*	*	*	*	600	775	1150	1600	2100
200	2	*	650	900	1350	1850	1950	*	*	*	*	*	650	850	1350	2100	3300
200	K	*	*	*	1125	1725	1725	*	*	*	*	*	*	*	1000	1300	7200
240	18	*	*	925	1200	1700	1500	*	*	*	*	*	*	*	1050	1400	2280
240	14	*	*	1025	1550	2100	2650	*	*	*	*	*	*	1275	2400	3300	4200
240	8	*	750	1200	2100	2850	3900	*	*	*	*	*	1950	3000	4500	5700	7800
240	3	*	*	825	1200	1700	1500	*	*	*	*	*	*	750	1050	1375	1950
240	2	*	*	850	1250	1800	1800	*	*	*	*	*	*	775	1150	1700	2700
240	K	*	*	*	*	1550	*	*	*	*	*	*	*	*	*	1200	1800
280	18	*	*	*	1125	1625	1200	*	*	*	*	*	*	*	1000	1325	1860
280	14	*	*	*	1400	2050	2400	*	*	*	*	*	*	840	1050	3000	3900
280	8	*	*	1050	1800	2650	3750	*	*	*	*	*	1000	2550	4200	5100	7500
280	3	*	*	*	1150	1625	1275	*	*	*	*	*	*	*	1050	1350	1860
280	2	*	*	*	1200	1750	1500	*	*	*	*	*	*	*	1100	1500	2250
280	K	*	*	*	*	1425	*	*	*	*	*	*	*	*	*	*	1560

NOTES:

a. Contact Distribution Workflow & Planning for service restorer/fuse types not given in table.

b. Service Restorer phase setting does not effect fuse coordination.

c. Coordination values are 3 times higher than curve crossing to provide adequate sensitivity margin.

* Will coordinate for all fault current values.

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C							F						
B	6136 MOVED TO FMO	YZZ	MOV	FRC	FRC	07/14/2026	E						
A	REVISION	-	-	-	JCE	01/01/2000	D						

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SERVICE RESTORER/FUSE COORDINATION TABLE

FMO DM6136.2

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6200
SYSTEM
ENGINEERING

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C	6213 MOVED TO FMO	YZZ	FRC	FRC	JJP	03/17/2026	F						
B	6242 MOVED TO FMO	YZZ	FRC	FRC	FRC	07/18/2025	E						
A	6222 MOVED TO FMO	JIK	FRC	FRC	KRG	09/16/2024	D	6241 MOVED TO FMO	YZZ	FRC	FRC	FRC	07/17/2026

DM6213 FIELD MAINTENANCE ONLY

ALL VERSIONS LISTED IN FMO ARE SUPERSEDED BY THEIR CURRENT VERSION FOUND INSIDE THE ELECTRIC DISTRIBUTION DESIGN MANUAL.

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SCOPE

This standard provides the proper single–phase primary transformer voltage selection for boosted and unboosted areas on 12kV distribution circuits.

PURPOSE

This standard was developed to maintain 114 volts minimum (phase to neutral) at the customer's service entrance, based on the Distribution Circuit Profile (Design Standard 6211)

DEFINITIONS

Boosted Area – a physical location on a 12kV circuit served by a booster to provide 7,200 volts from a 12,000/6,930 volt source for proper operation of 7,200 volt transformers.

Boosted Rating – the kVA nameplate rating of 100 or 333 kVA–1Ø and 1875 or 3750 kVA–3Ø.

Booster Ultimate Loading – the maximum allowable peak loading of a booster is established as 100 percent of booster rating.

STANDARD

A. Boosted Area

Transformers rated 7,200 volts should be selected for boosted areas, provided the booster connected kVA will not exceed 90 percent of the booster rating with the kVA additions included.

– When exceeding 90 percent booster rating, Electric Distribution Planning approval is required for 7,200V transformer additions.

B. Unboosted Areas

1. Transformers rated 6,930 volts will always be selected for new installations in unboosted areas.

2. Transformers rated 6,930 volts will always be selected to replace existing 7,200V transformers in unboosted areas more than 1–1/2 miles from the distribution substation.

3. Transformers rated 6,930 volts will always be selected to replace existing 7,200V transformers in unboosted areas less than 1–1/2 miles from the distribution substation, provided the cost associated with converting live front (7,200V) to deadfront (6,930V) transformers is moderate and the interruption of service does not exceed 1 hour for commercial or 6 hours for residential customers. Where a high cost and/or extended outage time for the conversion is required, the replacement use of 7,200V transformers is acceptable.

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Example:

Select the proper transformer primary voltage for the addition of 12–25 kVA single–phase transformers in a boosted area served by a 1875 kVA booster with 1400 kVA already connected.

1. Determine the booster loading requiring Electric Distribution Planning approval; 1875 kVA, booster rating (.9) = 1688 kVA

2. Determine total proposed connected kVA on the booster; 1400 kVA, existing + 300 kVA, proposed = 1700 kVA

3. Obtain Electric Distribution Planning approval for the proposed 7,200V transformer additions. Electric Distribution Planning should consider:

   – If the proposed additional transformers will result in the booster exceeding the booster ultimate loading due to actual demand.
   – If a 6,930 volt source should be brought into the area to serve the proposed additional transformers.

References:

1. Design Standard 6211, Distribution Circuit Voltage Profile
2. Service Planning Manual 353, Planned and Requested Outages

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DM6222 FIELD MAINTENANCE ONLY

ALL VERSIONS LISTED IN FMO ARE SUPERSEDED BY THEIR CURRENT VERSION FOUND INSIDE THE ELECTRIC DISTRIBUTION DESIGN MANUAL.

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C							F						
B							E						
A	6114 MOVED TO FMO	JIK	FRC	FRC	KRG	09/16/2024	D						

	Indicates Latest Revision		Completely Revised	X	New Page		Information Removed

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SCOPE

This criteria shall be used for the application of grounding banks. Grounding banks provide a grounded neutral source that is required by load additions which are served by 6.9kV transformers.

DEFINITIONS

A grounding bank installation consists of three–phase transformers connected grounded wye–delta and is used to provide a ground source for the primary neutral wire. The primary voltage rating of the transformers used can be 12 or 6.9kV. The secondary voltage shall be rated 480 volts or higher (see O.H. Standards page 1195).

APPLICATION OF GROUNDING BANKS

A. Why Grounding Banks?

A grounding bank may be installed to serve single–phase load additions using 6.9kV transformers when there are two or fewer grounding banks on a circuit and:

1. Extension of an existing neutral wire, beyond the proper location for a grounding bank, is double the cost of a new grounding bank installation.

2. A neutral connected to an existing grounding bank is available, but additional single–phase load will exceed the recommended kVA limit on the existing grounding bank (see paragraph B.5).

B. Design Considerations

The following lists several design considerations related to the application of grounding banks.

1. The available short–circuit current sensed by a protective device is reduced approximately 100 amps for each grounding bank between the fault location and the substation. To prevent desensitization of the substation ground relays, the number of grounding banks on a circuit is limited to three installations.

2. A grounding bank should be installed at a central location to enable future loads to take advantage of this neutral source. Since there will normally be a maximum of three grounding banks per circuit, each grounding bank should be located to cover one third of the area served by the circuit.

3. The recommended location for a grounding bank is on the unfused portion of a circuit, preferably on the feeder because the load on the grounding bank will be served by an energized neutral source except during times when the circuit is interrupted or the grounding bank has failed.

4. Neutrals established by grounding banks should only be used to serve transformers fed from the same circuit.

5. The following are approved grounding bank installations, allowable connected kVA unbalance between phases and maximum connected kVA loading.

Grounding Bank Installation	Allowable Connected kVA unbalance Between Phases	Maximum Connected kVA Loading (a)
3 – 50 kVA's	150 kVA	1500 kVA
3 – 75 kVA's	225 kVA	2250 kVA

(a) The maximum connected kVA allowed was set at 10 times the unbalance which a grounding bank may tolerate because the load unbalance on the average circuit is 10 percent.

b. For more information on overhead grounding banks, refer to O.H. Standards Page 1195.

6. Single–phase loads served from a grounding bank should be divided equally among the three phases to balance the total load as much as possible.

If the amount of unbalance cannot be kept within the limits set above, one of the following must be done:

a. Extend the neutral from the substation and remove the grounding bank. This alternative is recommended if there is significant load growth potential in the area.

b. Serve part of the load with 12kV single–phase transformers. Use enough 12kV transformers to reduce the amount of 6.9kV connected kVA below the recommended limit.

c. Extend the neutral from another grounding bank, either new or existing, and transfer some 6.9kV load to this neutral. These neutrals are not to be connected to each other.

DM6241 FIELD MAINTENANCE ONLY

ALL VERSIONS LISTED IN FMO ARE SUPERSEDED BY THEIR CURRENT VERSION FOUND INSIDE THE ELECTRIC DISTRIBUTION DESIGN MANUAL.

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SCOPE

This standard uses graphic representation to illustrate the total owning cost (installation plus losses) of different conductor sizes operating at specific load levels. The information presented in this standard is supplemental to Design Standard 5923, "Prefered UG Cable Installation Criteria".

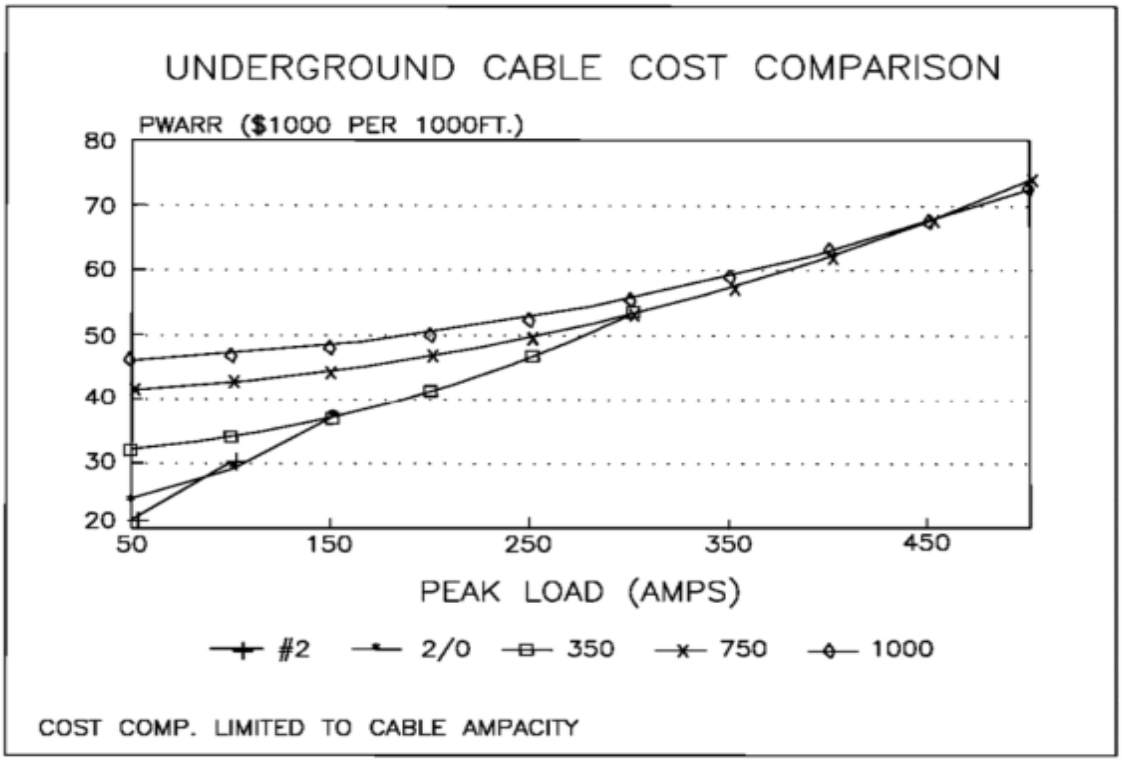
PURPOSE

This standard was prepared so District Engineering personnel would be able to select the least costly conductor size based on the amount of load which the conductor would serve. The graphs also make it possible for the district engineer to determine the cost penalty associated with installing a larger conductor than necessary to provide adequate tie capacity.

CRITERIA

The cost illustrated in the graphs below represent the PWARR to install 1000 feet of conductor plus the demand and energy charges associated with distribution system losses. In addition to the conductor cost the Underground Cable Cost Comparison includes the cost of connectors while the Overhead Conductor Cost Comparison includes the cost of poles, crossarms and anchors.

The graphs were constructed assuming the peak load is constant over the physical life of the conductor (20 years for UG, 30 years for OH). An average peak load to be expected over the life of the conductor must be calculated prior to using the graphs if the peak load is not constant (e.g. due to load growth, specific load additions, etc.).



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C							F						
B	6241 MOVED TO FMO	YZZ	FRC	FRC	FRC	07/17/2026	E						
A	REVISION	-	-	-	CVN	01/01/1989	D						

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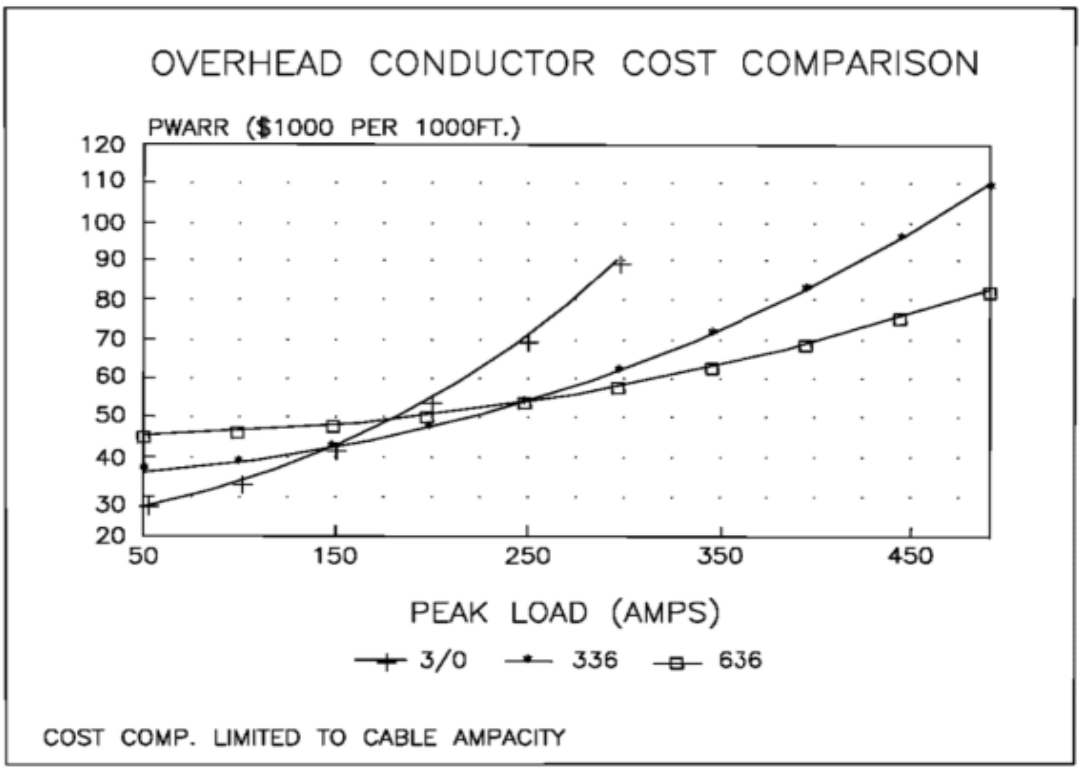

Note: PWARR is for overhead conductor on newly constructed pole line and includes the installed cost of the conductor, poles, crossarms and anchors.

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The following constants and assumptions were used to deveop the graphs:

1. LACC — UG = 16.7% — OH = 16.13%
2. Physical Life — UG = 20 yrs — OH = 30 yrs
3. Energy Charge — UG = 4.62¢/kWH — OH = 5.44¢/kWH
4. Demand Charge — UG = $97.63/kW — OH = 112.5/kW
5. Loss Factor = 0.25
6. Peak Responsibility Factor = 0.80
7. Construction Cost Contingencies = 20%
8. Underground Conductor Parameters:

3–1/c #2 PECN–PEJ	PWARR = $18,042/1000'	R = .3339 ohms/1000'
3/c #2/0 PECN–PEJ	PWARR = $22,656/1000'	R = .1663 ohms/1000'
3/c 350 XLPECN–PEJ	PWARR = $31,504/1000'	R = .0649 ohms/1000'
3/c 750 XLPECN–PEJ	PWARR = $41,225/1000'	R = .0345 ohms/1000'
3/c 1000 XLPECN–PEJ	PWARR = $45,625/1000'	R = .0286 ohms/1000'

9. Overhead Conductor Parameters:

3/0 AWG ACSR/AW	PWARR = $25,726/1000'	R = .1500 ohms/1000'
336 AWG ACSR/AW	PWARR = $35,335/1000'	R = .0630 ohms/1000'
636 AWG ACSR/AW	PWARR = $44,633/1000'	R = .0330 ohms/1000'

10. The book life, which is usually the physical life, is 28 years for UG cable and 36 years for OH conductor. PWARR figures used in this standard incorporated these book lives. However, the energy and demand charges used in this standard reflect historical conductor performance, 20 years for UG cable and 30 years for OH conductors.

The table below present the optimum conductor loading for each conductor size in tabular form:

Underground Cable Size	Optimum Conductor Peak Loading
3–1/c #2	0 – 84 amps
3/c #2/0	85 – 151 amps
3/c 350	152 – 290 amps
3/c 750	291 – 445 amps
3/c 1000	> 445 amps

overhead Cable Size	Optimum Conductor Peak Loading
3/0	0 – 151 amps
336	152 – 254 amps
636	> 254 amps

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SCOPE

This standard provides a method of evaluating various alternatives so that the most economical one is identified. The advancement of an overload project to improve reliability is also discussed. For the latest calculation tools used to determine the present value of electric distribution projects, contact Distribution Planning.

PURPOSE

Present Worth of Annual Revenue Requirements (PWARR) has been selected by the Financial and Economic Analysis section as the appropriate analytical tool for distribution engineering projects. This is because is measures the total impact of a project on SDG&E's customers given the regulated enviornment of the utility.

DEFINITIONS

LACC (Levelized Annual Capital Cost) – A factor applied to the installed equip–ment costs to account for the annual levelized depreciation, return on investment, income taxes, property taxes and salvage.

A/P,n – Converts a present value into an annual series of payments over n years. Refer to the Economic Assumptions Manual, Table 2–1, for the current value.

P/A,n – Provides the present value of an annual series of payments made for n years. Refer to the Economic Assumption Manual, Table 2–1, for the current value.

P/F,n – Provides the present value of a future payment made n years from today. Refer to the Economic Assumption Manual, Table 2–1, for the current value.

Inflation Factor – Accounts for the rise in the price of goods and services over n years.

CRITERIA

The capital portion of Equation 1 below converts the equipment installed cost (Cost) into an annual series using the LACC Factor to account for taxes and return on investment. Then it sums all these payments into a present value at the time of construction using the P/A factor. In contrast, the O&M portion accounts for those non–capitalized expenditures which are included at the time of installation (O&M) and so the LACC and P/A factors are not applied.

$$PWARR = [(\text{Inflation Factor})(P/F,n)][(\text{Cost})(\text{LACC})(P/A,n)+(\text{O\&M})] \qquad \text{Equation 1}$$

$$\text{Inflation Factor} = (1+i)^{n} \qquad \text{Equation 2}$$

where: i = rate of inflation

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APPLICATION

PWARR analysis is used to compare alternative construction projects economically. Normally there are benefits associated with each project which have not been assigned a dollar amount and, therefore have not been considered. When the PWARR of one alternative is within 5 percent of another alternative it is appropriate to consider unassigned benefits (i.e. improvements in customer service, sensitivity to changes in imput variables, lowest installed cost, etc.) in the decision.

A typical application of the PWARR analysis is shown in Example 1. It considers delaying the construction of a new circuit for two years by increasing tie capacity, thus allowing a load transfer to occur. The alternative is to construct the new circuit next year. Although the lives of the two alternatives are not the same (one ends in 28 years, the other 30), the Finance and Economic Analysis section feels Equation 1 provides a good approximation provided the difference in lives does not exceed 5 years.

Example 1

One feeder in a 4–EB5" duct is rated at 475 amps but has a projected load of 500 amps next year. To eliminate the projected overload consider shedding 100 amps to an adjacent circuit by constructing a tie next year for $75k. This will delay having to construct a new circuit, at a cost of $450k for an additional 2 years. The alternative is to construct the new circuit next year. Which alternative is the least costly considering all costs were provided in next year's dollars?

The following factors were obtained from the economic Assumptions Manual:

LACC = 0.167, FERC account E367 (book life = 28 yrs)
P/A, 28 = 8.2217
P/F, 2 = 0.8029
A/P, 2 = 0.5886
i = 5%

ALTERNATIVE 1: Construct a tie next year and defer the new circuit 2 years.

Inflation Factor = $(1.05)^2$ = 1.1025

Construct tie PWARR = (75k)(0.167)(8.2217) = $102,976

Construct circuit 2 yrs later PWARR = (1.1025)(.8029)(450k)(0.167)(8.2217) = $546,929

Total Cost $649,905

ALTERNATIVE 2:

Construct circuit next year PWARR = (450k)(0.167)(8.2217) = $617,861

Conclusion Alternative 2 is approximately 5% less expensive and it should be selected unless there are sufficient unassigned benefits to favor alternative 1.

Example 2

Consider advancing the construction of a new circuit 2 years to achieve an annual reliability benefit of $100,000. The circuit cost is the same as in Example 1. Is this cost effective?

Construct line next year – (450k)(0.167)(8.2217) = $617,861

Construct line 2 yrs later – (1.1025)(0.8029)(450k)(0.167)(8.2217) = $546,929

PWARR of advancement = 617,861 – 546.929 = $70,932

C/B ratio = (70,929)(A/P,$_2$)/100,000 = 0.4175

Conclusion: It is cost effective to move the project ahead 2 years.

Example 3

Consider the effect of adding O&M expenditures to the construction in Example 1. O&M associated with constructing the new line is $75k, $15k for constructing the tie.

ALTERNATIVE 1:

Construct tie line next year PWARR = $102,976 + $15,000 = $117,976

Construct ckt 2 yrs later PWARR = $546,929 = (75k)(1.1025)(.0829) = $613,319

Total cost = $731,295

ALTERNATIVE 2:

Construct new circuit next year PWARR = $617,861 + $75,000 = $692,861

Conclusion: Alternative 2 is still approximately 5% less expensive and should be selected unless there are sufficient unassigned benefits to favor alternative 1.

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TABLE 1

Distribution Substation Transformer Loading Guide

Nameplate Rating Of Each Bank MVA	Number of Transformer Banks In Substation	Nameplate Capacity (MVA)	Firm Substation Peak MVA Load ① Summer(adverse)/ Winter	W/in 15 min. Immediate Load Shed MVA Level ② Summer(normal)/ Winter	W/in 4 Hrs Secondary Load Shed MVA Level ③ Summer(normal)/ Winter	Maximum Sustained Load on Any ④ Transformer (Summer/Winter %)
6/7.5	1	7.5	8.5/9.5	-	-	113/127
	2	15	17/19	11/13	8.5/9.5	147/173
	3	22.5	25.5/28.5	21/15	17/19	140/167
	4	30	34/38	30/37	26/29	133/164
10/12.5	1	12.5	14.5/17	-	-	116/136
	2	25	29/34	25/25	19/22	200/200

NOTES:

1. Installation of additional transformer capacity is required at this MVA Load Level.
2. When one transformer fails, load must be shed within 15 minutes to reduce loading to or below this MVA level.
3. After transformer failure, substation load must be shed or transferred to this MVA level within four hours.
4. This value is the maximum percent load at any time each of the remaining transformers for loss of a single transformer. In this context "sustained" means longer than momentary, i.e. longer than 5 minutes.

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SDG&E ELECTRIC DISTRIBUTION DESIGN MANUAL

SHEET 1 of 1

DISTRIBUTION SUBSTATION PLANNING GUIDLINES

FMO DM6312

SCOPE

This standard shows typical distribution substation equipment arrangements and provides guidance on the type of equipment used.

PURPOSE

The purpose of this standard is to provide guidelines for the general arrangement and ratings of equipment in typical distribution substations. It is to be used for planning new substations, and expansions to existing ones. Coordination between District Engineering, Substation Engineering and Transmission Planning is needed.

GUIDELINES FOR DISTRIBUTION SUBSTATION

A. Station Capacity

Property purchased for a new 12kV distribution substation should be adequate for a toral nominal capacity of 100, 75 or 50 MVA, using 15/20/25 (28) MVA transformers. Remote areas and special locations are exceptions. Selection of the substation property is discussed in Design Manual 6330, titled "Distribution Substation Siting Procedures". The ultimate one-line diagrams for 50, 75 and 100 MVA distribution substations are shown in the diagrams on page 6312.2 thru 6312.3. These diagrams are intended to guide the District Engineer in planning activities and not to dictate the actual substation design.

B. Station Getaways

New 12kV circuit getaways will normally be underground. The standard getaway will be one run of 1000 kcmil aluminum cable. Overhead getaways may installed at rural substations where only a few circuits are planned and area aesthetics are not materially affected. The number of circuits installed in a duct bank is dependent on the economics of reducing cable ampacity. Design Manual 5221, "Feeder Cable Ampacities Base on Thermal Loading Limits" provided guidance on determining cable ampacity.

C. Four-Wire Distribution

All new 12kV substation are to be designed for compatibility with four-wire operation requirements according to Design Manual 6621, "Application of Primary Neutral". New circuit construction is to include installation of a neutral conductor.

D. Bus Capacitors

All new 12kV substations are to be designed with an ultimate capacitor rating of 6 MVAR for each 28 MVA transformer bank. Substation capacitors for var load requirements should be installed in accordance with the "Capacitor Application Criteria", Design Manual 5811.

E. Equipment

Substation equipment, unless acquired from existing stock, should ultimately conform to the following:

1. The 138kV and 69kV switchyard equipment will be rated as specified by transmission planning and will have minimum capacity sufficient to accommodate the ultimate load of the distribution substation.
2. The transformer bank will be three-phase, 15/20/25 MVA (55°C rise) and a top rating of 28 MVA (65°C rise). The cooling classes are ONAN/ONAF/ONAF. IEEE C57.12.00 ambient temperature conditions apply which allows for a 40°C Max ambient (considering an average of 30°C over 24-hour period). The transformers have LTCs which have ± ten percent adjustment on the low side voltage.
3. The 12kV switchyard will provide 2,000 amp main bus capacity with a 2,000 amp bus tie breaker. Low side transformer breaker positions will have a short time overload capability compatible with transformer loading Design Manual 6311. The 12kV feeder breakers will be rated 1,200 amps with an 18–20kA short circuit interrupting capability.
4. All new substations will include substation SCADA (status and control) in lieu of DPR equipment.

Typical ultimate equipment arrangements for distribution substations are shown on the following pages. Actual arrangements of new or existing substations may be planned differently depending on physical, economic, and reliability considerations.

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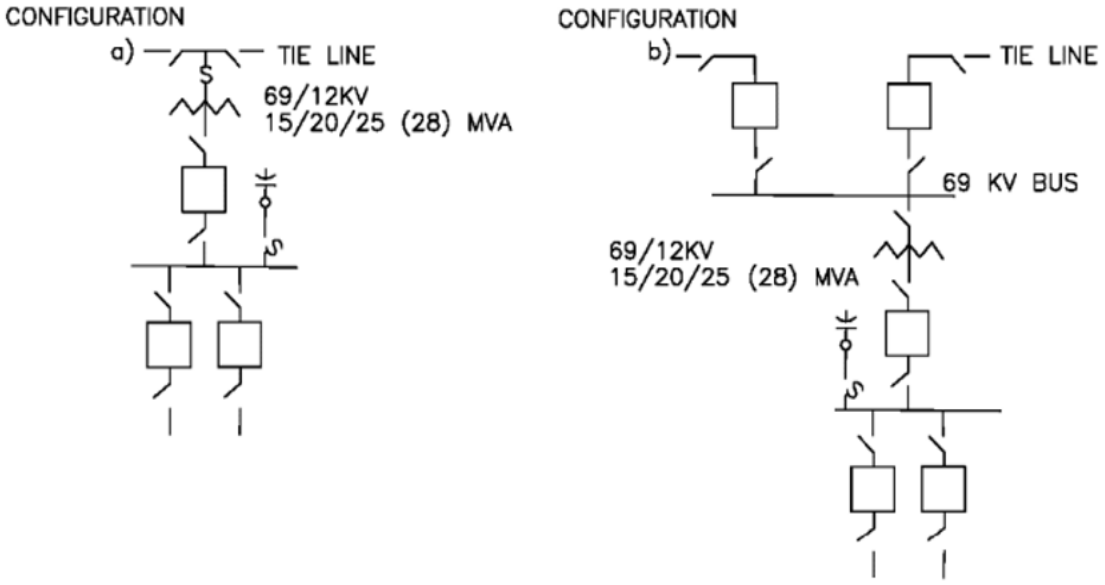
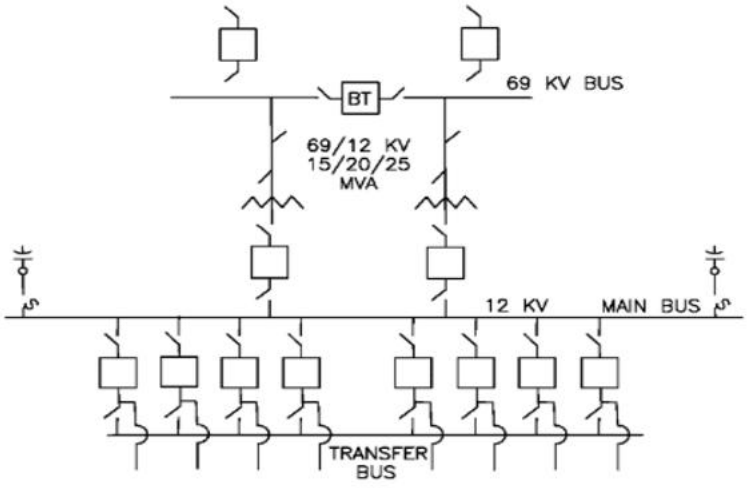
F. One Transformer Bank Substation



1. Configuration a) – Fuses are installed on the high side of 25 MVA banks only if all of the following three conditions exist:
   a. The transmission source to the substation is tapped off a tie line, i.e., where there is no isolation device in the tie line within the substation perimeter; only an isolation device in the connection from the tie line to the sub.
   b. There is transfer trip capability at the substations at the ends of the tie line (so the fuse only provides secondary protection to the bank).
   c. The tie line is not critical.
2. Configuration b) – A mod switch is installed on the high side of the transformer only when justified by Transmission Planning.

G. Two Transformer Bank Substation



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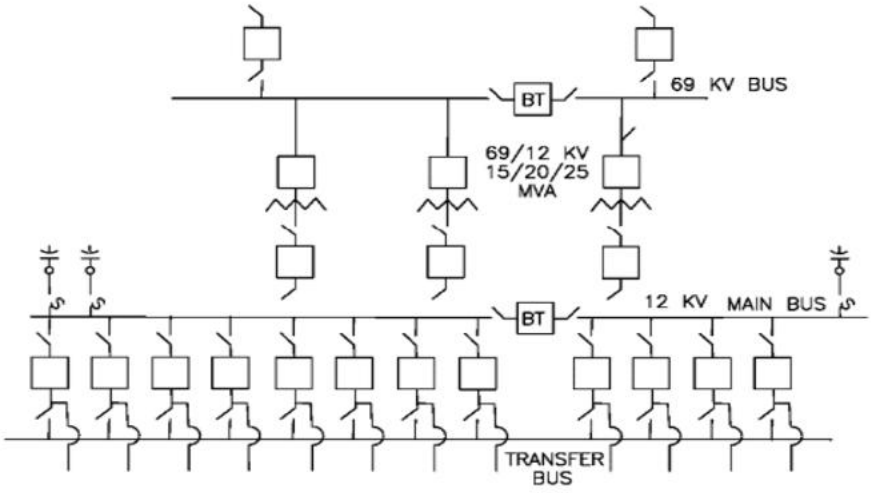
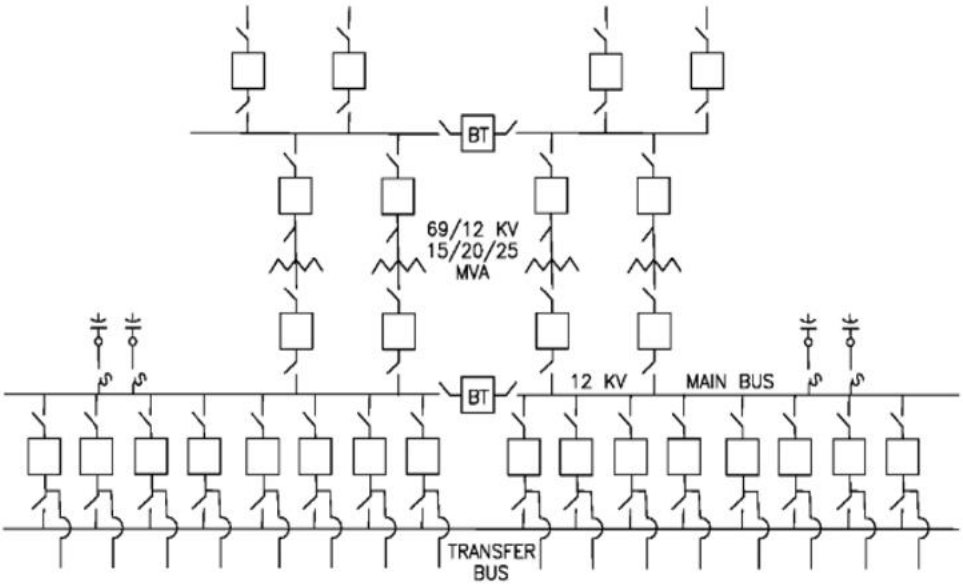
H. Three Transformer Bank Substation



I. Four Transformer Bank Substation



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A. The following criteria shall be applied to the design and development of distribution substations to ensure reliability of service:

1. Substation Transformers – Additional transformer capacity will be considered when:

   a. Loss of a single transformer may cause an interruption to major commercial/industrial load that cannot be restored through use of 12Kv circuit ties to other substations.

   b. Loss of a single transformer may cause an interruption to more than an acceptable amount of load that cannot be restored through use of 12Kv circuit ties to other substations within a reasonable period of time.

   c. Substations serving single customers are exceptions to the above criteria.

2. Substations With Radial Supply – A second transmission source to a distribution substation will be considered when:

   a. Loss of a single overhead source may cause an interruption to major commercial/industrial load that cannot be restored through use of 12Kv circuit ties to other substations. Substations serving single customers are an exception.

   b. The normal peak load of the substation exceeds 15 MW.

   c. The frequency outage rate of the single transmission source exceeds the system average by 100 percent. The system average frequency outage rate may be obtained from transmission.

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B. The guidelines listed below shall be followed during the design, development and normal operation of distribution substations in order to limit fault currents on the distribution system to acceptable values.

The guidelines are as follows:

1. Maximum of 10,000 amp (symmetrical line–to–ground fault current).

2. Maximum of two units (transformers or gas turbines, each with impedance equivalent to or greater than ten percent on a 20 MVA base) paralleled per bus section during normal conditions.

3. Maximum of three units paralleled during contingency conditions (not to exceed 12 hours per occurence).

NOTES:

Guideline B.1. requires the installation of neutral reactors at substations where line–to–ground fault currents are greater than the specified value. One neutral reactor per transformer will be provided during the development of the standard 100 MVA ultimate distribution substation. Distribution substations with gas turbine installations will also require neutral reactors for the gas turbine generators.

Guideline B.2. limits fault currents for all three–phase faults to a typical value of 13,600 amps. This presumes a typical system impedance of 1.8 percent on a 20 MVA base. This guideline requires the 12kV bus tie breaker to be operated normally open to isolate two units on each 12kV bus section.

In order to meet the requirements of guideline B.3., relaying scheme will be provided which automatically closes the 12kV bus tie breaker following a transformer failure in a three or four bank substation. This procedure is required to obtain uniform loading and avoid dropping load immediately following a transformer failure.

For additional information, refer to "Application Guidelines for Limiting Distribution Fault Currents" (ELI 230).

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