2025
ELECTRIC DISTRIBUTION DESIGN MANUAL
FIELD MAINTENANCE ONLY

Historical Record: 8/22/2025
External Version

SDGE™

ATTENTION:

- The contents held within this book are for field maintenance only. Every effort should be made, when possible, to upgrade to current standards.

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SUMMARY OF CHANGES

DATE	STANDARD PAGES	QTY	FILE NAME
09/20/24	NEW RELEASE, 6101, 6114, 6201, 6222	5	DMFMO2024v0920.pdf
02/21/25	5201, 5223	2	DMFMO2025v0221.pdf
08/22/25	6201, 6242	2	DMFMO2025v0822.pdf

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GENERAL
INFORMATION

5000
GENERAL
INFORMATION

5000 - No FMO standards for this section.

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OVERHEAD LAYOUT SYSTEMS

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PAGE	SUBJECT
5223	SINGLE FAMILY RESIDENTIAL SECONDARY SYSTEMS

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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ALL VERSIONS LISTED IN FMO ARE SUPERSEDED BY THEIR CURRENT VERSION FOUND INSIDE THE ELECTRIC DISTRIBUTION DESIGN MANUAL.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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REV	CHANGE	DR	BY	DSN	APV	DATE	REV	CHANGE	DR	BY	DSN	APV	DATE
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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):

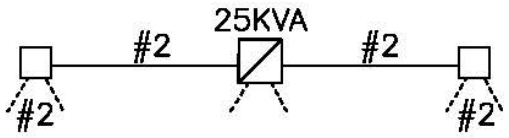
   a. A single-sided and double-sided array combination can be used effectively to serve lots of irregular width or layout (Such as in a cul-de-sac). The combination array must be constructed as shown in Example 3 where the variation can only be used directly off the transformer; not as an extension from 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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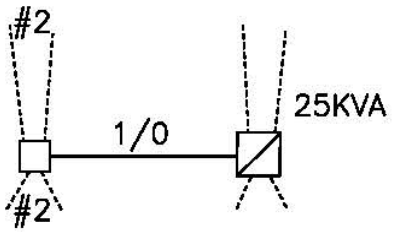
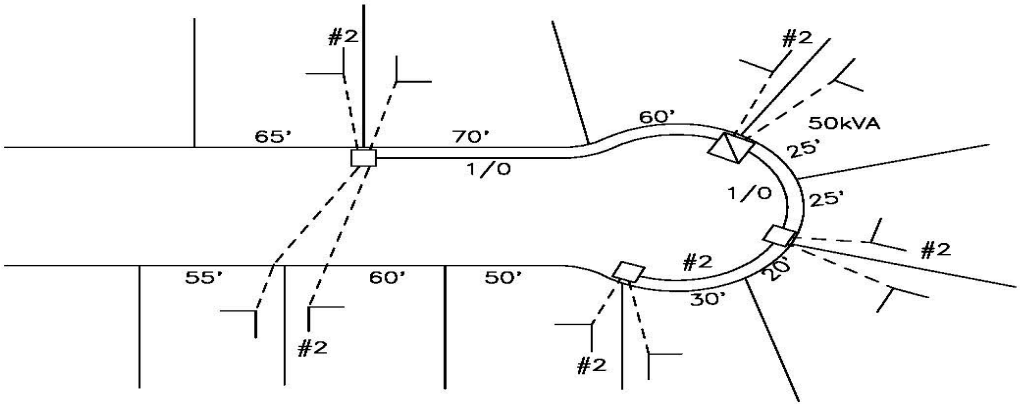
Select the double-sided optimum array for the subdivision described in Example 1 having a 90' long service (50' wide streets).

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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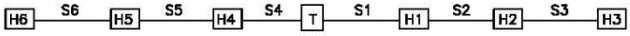

Sq. Ft.: 0–1299 SINGLE–SIDED

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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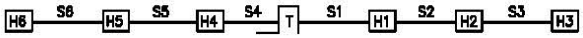

Sq. Ft.: 1300–1999 SINGLE–SIDED

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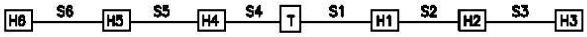
C						F					
B	FORMATTING	JIK	-	-	02/21/2020	E					
A	ORIGINAL ISSUE	-	CVN	RDG	01/01/1987	D					

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

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
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

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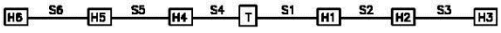

H1–H4 SHORT=1/0–1/0

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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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

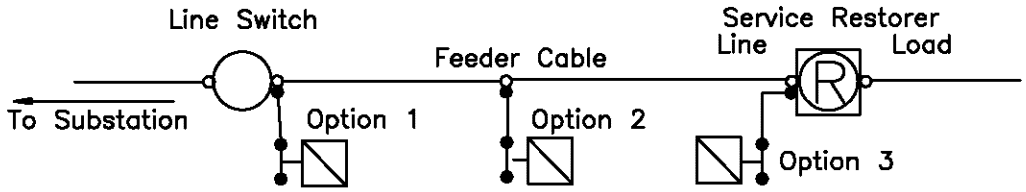
a. Consideration must be made regarding the location and length of the un–fused cable segments when locating the service restorer. As a general guide, locate the service to maximize the amount of load on the line side of the device and to maximize the circuit length on load side. The service restorer 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.

FOR FIELD MAINTENANCE ONLY

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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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.

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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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