GROUNDING AND BONDING

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GROUNDING

The ground electrode conductor shall be bare. Ground electrode conductors shall be a minimum size of No. 4 copper (solid or stranded) and must be securely fastened to the building or structure with approved fastening devices. The spacing of such devices shall not exceed 2 feet. Aluminum wire is not acceptable to be used as the grounding conductor.

When a ground rod is used as the grounding electrode, it shall be a minimum 5/8 inch X 8 foot copper clad ground rod driven vertically into the ground.

Where a rock bottom is encountered, the ground rod shall be driven at an oblique angle not to exceed 45 degrees from the vertical or shall be buried in a trench that is at least 2 1/2 feet deep.

The ground rod shall be installed so that at least 8 feet of rod is in contact with the soil.

The ground rod connector shall be of a type approved for direct burial. Not more than one conductor shall be connected to the grounding electrode by a single clamp, unless the clamp is listed for multiple conductors.

The grounding electrode shall have a resistance to ground of 25 OHMS or less. Where the resistance exceeds 25 OHMS, two or more electrodes in parallel not less than 6 feet apart shall be used to obtain the necessary resistance to ground.

When a concrete enclosed electrode (UFER Ground) is used, it shall be encased by at least two (2) inches of concrete foundation or footing that is in direct contact with the earth, consisting of at least 20 feet or more of bare solid copper conductor not smaller than No. 4 AWG.

When a UFER Ground is used, it must be inspected by either the inspector within whose jurisdictional boundary it lies or, if in an area not requiring such inspection, by an approved Cooperative employee, prior to being encased in the concrete.

The grounding electrode conductor shall contain no splices from the equipment it is intended to ground to the grounding electrode it is connected to.

A natural gas or liquid propane gas line shall not be used as a grounding electrode.

BONDING (Unfused Areas)

Bonding is required on all enclosures, equipment, raceways, and fittings which contain unfused service conductors.

Nipples and bushings installed with eccentric or concentric lock nuts must be bonded with ground bushings, wedges, or other approved devices.

Bond conductor size shall be determined by the ampere rating of the service entrance equipment as shown on the grounding and bonding table.

Bonding jumpers shall be installed around any section of non-metallic duct, pipe, device or fitting that will break the continuity of the ground.

Self bounding hubs (Myers or equivalent) shall not be used on multi-centric knockouts, unless the largest knockout is used.

All metallic parts of an irrigation system which are not intended to carry current must be permanently bonded to an unfused and unswitched ground conductor which extends back to the transformer bank secondary ground. It is not satisfactory to merely bond the equipment to a driven ground rod or well casing if that ground rod or casing is not interconnected with the transformer ground by metallic conductor. **This means that in all cases, the consumer's wiring must consist of four wires. These wires are the three current-carrying phase conductors and a fourth wire called a grounding conductor.** A grounding conductor is one which is not intended to carry load current, but instead, provides the interconnection between the transformer bank ground and all grounds on the consumer's equipment and shall be sized as shown in N.E.C. 250-94.

Interior metal water piping systems shall be bonded to the service entrance enclosure with conductor sized to the ampacity of the main bus per National Electric Code (N.E.C.) 250-94. In multiple occupancy buildings where the interior metal water piping system for the individual occupancies is isolated from all other occupancies by use of non-metallic pipe, each water system may be bonded to the panel board or switch board enclosure supplying that occupancy sized per N.E.C. 250-95.

Other metal piping systems (e.g. gas pipe) shall be bonded to the service equipment enclosure with a conductor sized to the largest branch circuit or feeder supplying the facility, sized per N.E.C. 250-95. Bonding of gas pipe shall be made on the “House” side of the insulated coupling located adjacent to gas meter. Non-conductive paint must be removed at threads terminal strips, etc., to assure a good electrical connection.

Insulated bounding conductors shall have a green insulation.

GROUNDING AND BONDING TABLE

MINIMUM SIZE OF BONDING/EOUIPMENT GROUNDING, GROUNDING ELECTRODE CONDUCTORS AND GROUND BUS

Maximum Ampere Rating	Size of Equipment Grounding or Bonding Conductor Minimum (AWG or MCM) NEC 250-95 See Note 1		Size of Grounding Electrode Conductor Minimum (AWG or MCM) NEC 250-94 See Note 2 & 4	Size of Main Bonding Jumper, Minimum (AWG or MCM) NEC 250-79 See Note 3	
	Copper	Aluminum	Coper	Coper	Aluminum
20	12	10			
60	10	8			
90	8	6			
100	8	6	4	6	4
150	6	4	4	6	4
200	6	4	4	4	2
300	4	2	2	2	1/0
400	3	1	1/0	1/0	3/0
500	2	1/0	1/0	1/0	3/0
600	1	2/0	2/0	2/0	4/0
800	1/0	3/0	2/0	2/0	4/0
1000	2/0	4/0	3/0	3/0	250
1200	3/0	250	3/0	250	250
1600	4/0	350	3/0	300	400
2000	250	400	3/0	400	500
2500	350	500	3/0	500	700
3000	400	600	3/0	600	750
4000	500	800	3/0	750	1000
5000	700	1200	3/0	900	1250
6000	800	1200	3/0	1250	1500

NOTES:

1. For sizing bonding conductor for gas line, per N.E.C. 250-122. For sizing any bond conductor required on The Load Side of Fuses or Circuit Breakers.

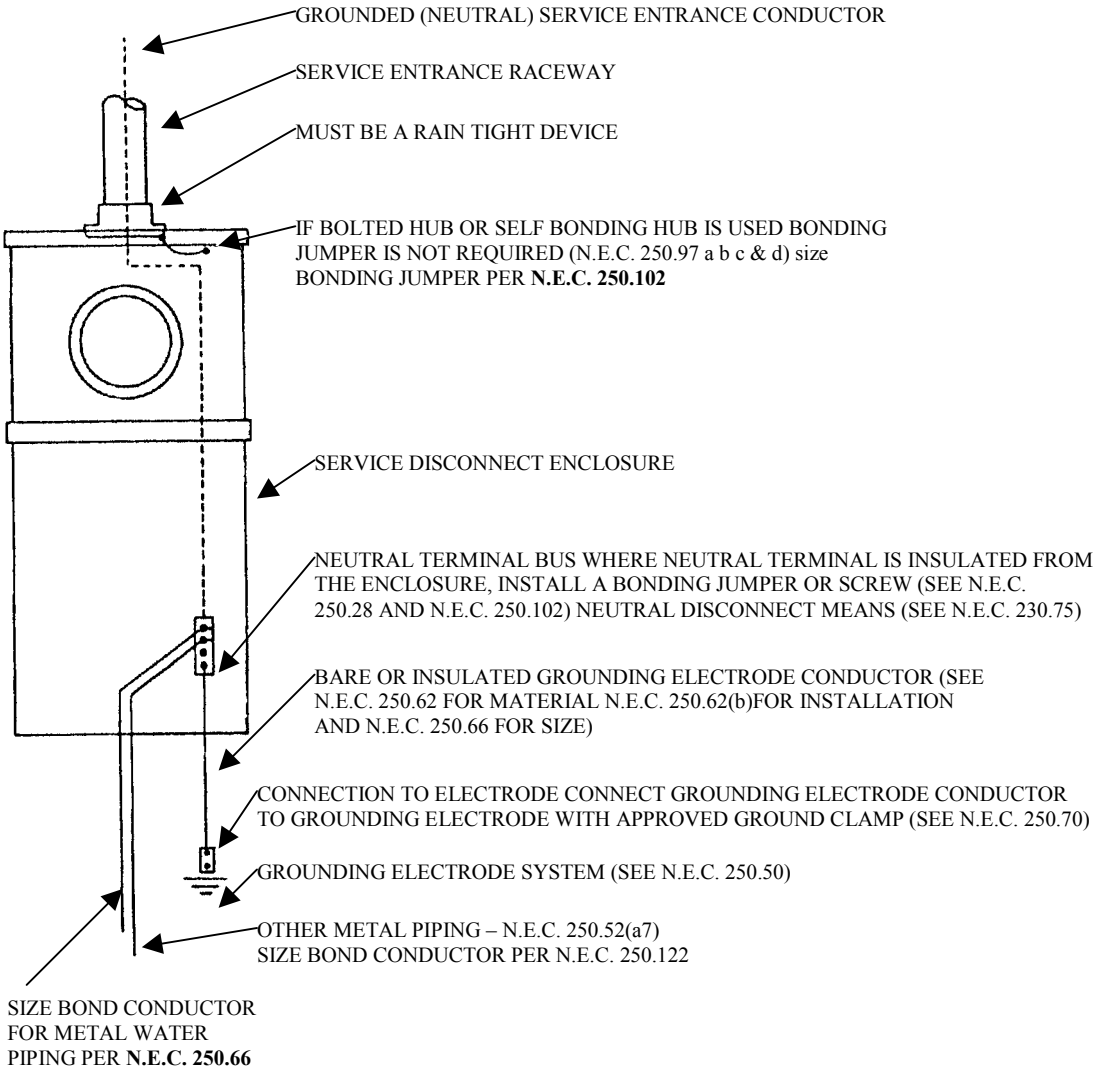
2. For sizing water bonds per N.E.C. 250-66.

3. For sizing main bonding jumper from equipment grounding bus to neutral bus, per N.E.C. 250-102. For sizing conductor used for bonding unfused nipples and equipment.

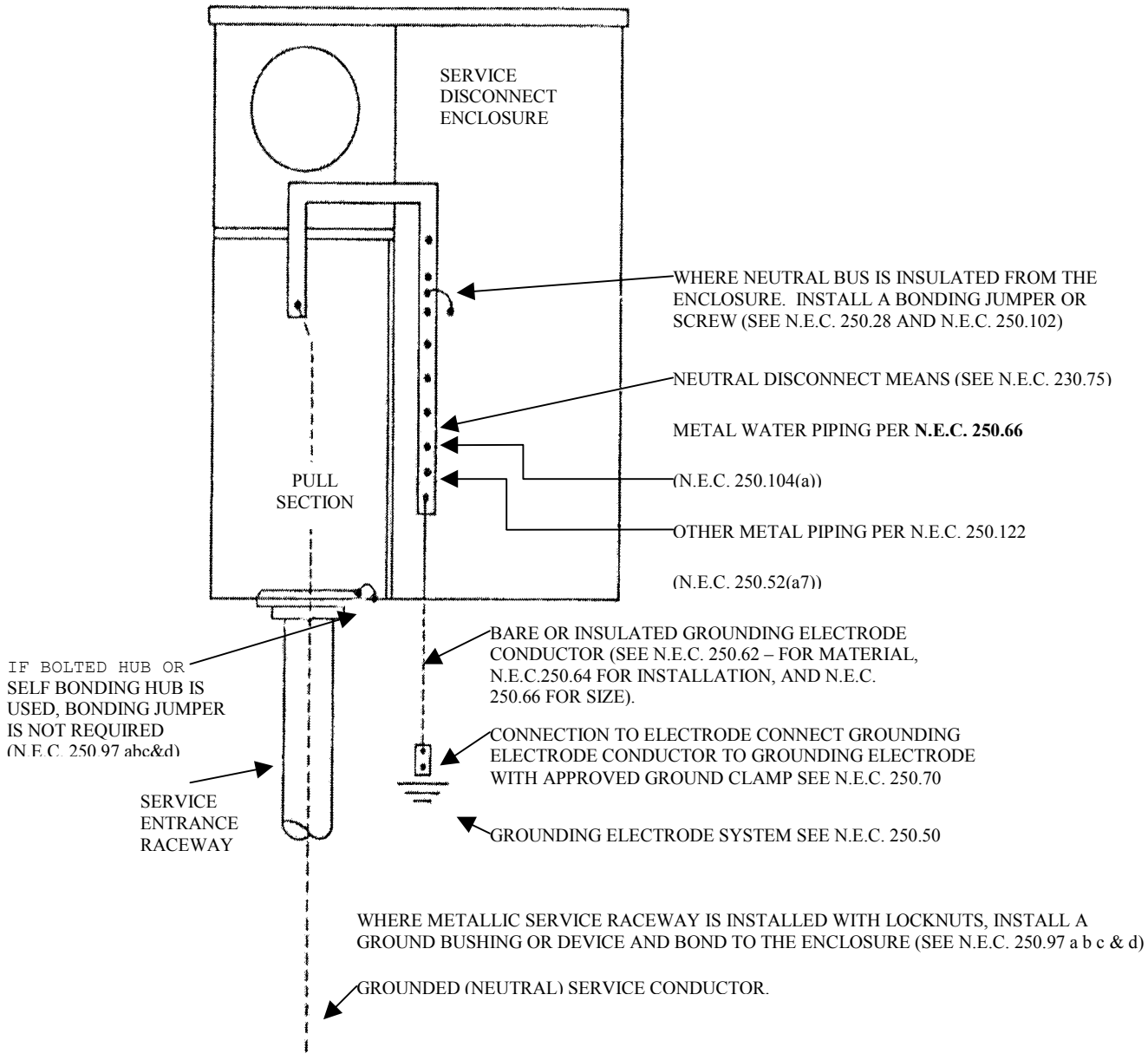
4. Grounding electrode conductors need not be larger than #4 copper if there is only one connection between the concrete encased electrode or man made electrode (example—ground rod) & grounded system conductor (neutral conductor), per N.E.C. 250-66 ex.1-a and b.

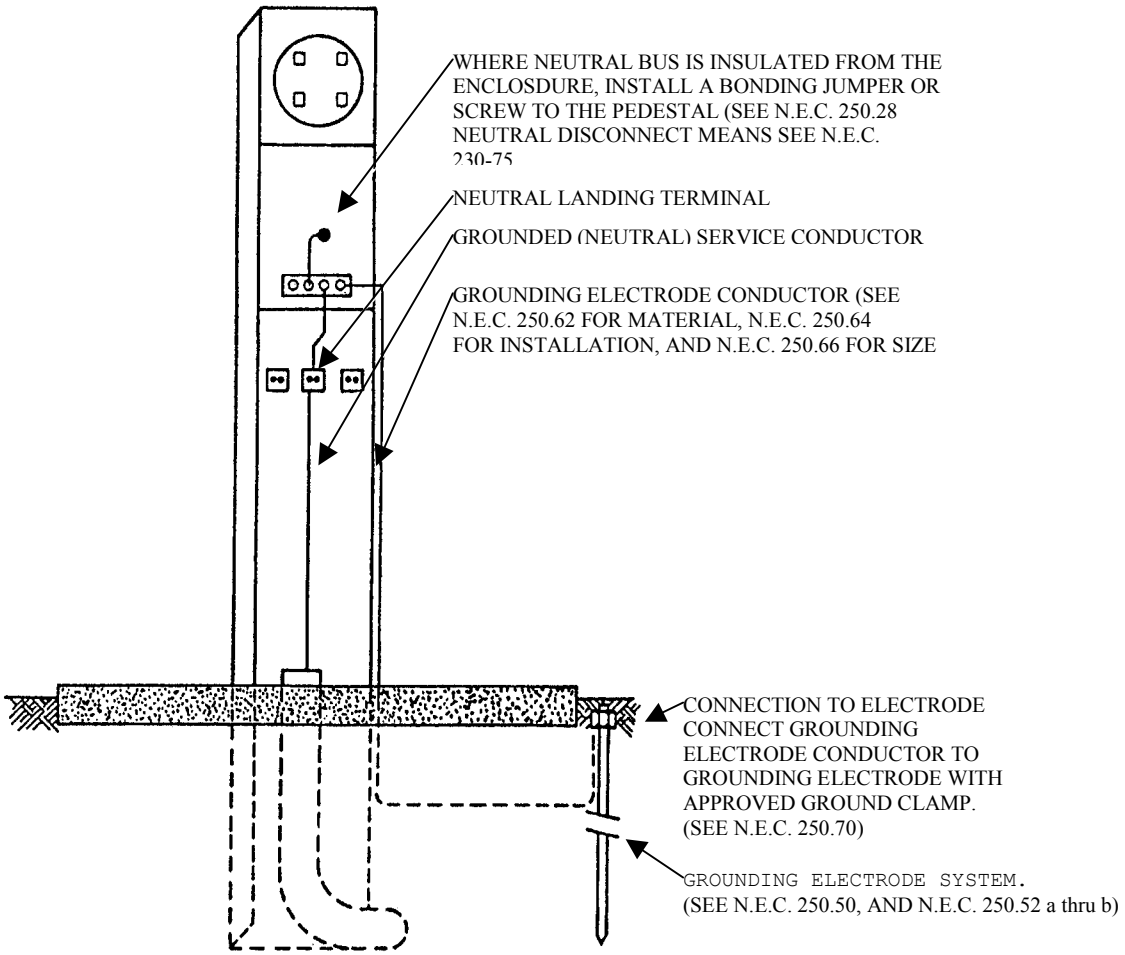
GROUNDING AND BONDING

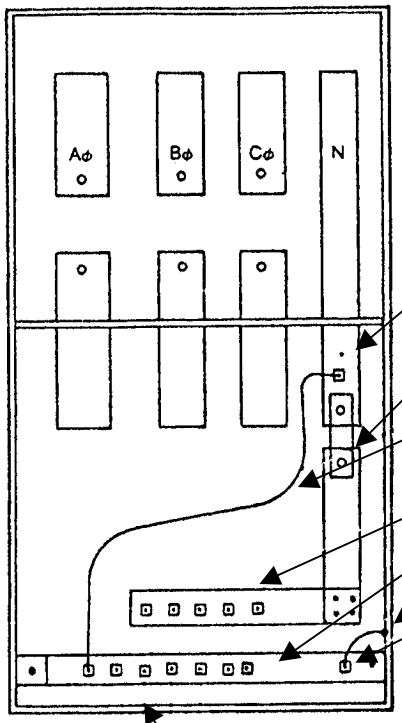
TYPICAL RESIDENTIAL OVERHEAD SERVICE—ALL IN ONE (SINGLE FAMILY) MAX 200 AMP—SINGLE PHASE



GROUNDING AND BONDING
TYPICAL RESIDENTIAL UNDERGROUND SERVICE (SINGLE FAMILY)MAX 200 AMP.




WHERE NEUTRAL BUS IS INSULATED FROM THE ENCLOSDURE, INSTALL A BONDING JUMPER OR SCREW TO THE PEDESTAL (SEE N.E.C. 250.28 NEUTRAL DISCONNECT MEANS SEE N.E.C. 230-75
NEUTRAL LANDING TERMINAL
GROUNDED (NEUTRAL) SERVICE CONDUCTOR
GROUNDING ELECTRODE CONDUCTOR (SEE N.E.C. 250.62 FOR MATERIAL, N.E.C. 250.64 FOR INSTALLATION, AND N.E.C. 250.66 FOR SIZE
CONNECTION TO ELECTRODE CONNECT GROUNDING ELECTRODE CONDUCTOR TO GROUNDING ELECTRODE WITH APPROVED GROUND CLAMP. (SEE N.E.C. 250.70)
GROUNDING ELECTRODE SYSTEM. (SEE N.E.C. 250.50, AND N.E.C. 250.52 a thru b)



CONNECTION FOR MAIN BOND JUMPER
AHEAD OF NEUTRAL DISCONNECT LINK.

NEUTRAL DISCONNECT LINK

MAIN BONDING JUMPER(S)
N.E.C. 250.28
N.E.C. 250.102
SIZE PER **N.E.C. 250.102**

ALL NEUTRAL WIRES TO BE PLACED ON NEUTRAL BUS.

ALL BOND WIRES N.E.C. 250.28 TO BE PLACED ON BOND BUS.

ENCLOSURE GROUNDED N.E.C. 250.80.

(A WIRE MAY NOT BE NECESSARY IF GROUNDING
BUSBAR HAS BEEN INSTALLED ON A CLEANED
SURFACE OF THE FRAME WITH BOLTS OF ADEQUATE
SIZE AND STRENGTH.)

TO GROUNDING ELECTRODE N.E.C. 250.70 SIZE PER N.E.C. 250.66
PIPING SYSTEMS PER N.E.C. 250-80
METAL WATER PIPING PER N.E.C. 250.104a, SIZE PER N.E.C. 250.66
OTHER METAL PIPING PER N.E.C. 250.52a7, SIZE PER N.E.C. 250.122

SHORT CIRCUIT PROTECTION

The national electric code, state, county and municipal codes and/or regulations require that service entrance equipment shall be suitable for the short circuit current available at its supply terminals.

It is the responsibility of the consumer to install service entrance equipment and protective devices (fuses or circuit breakers) capable of interrupting and withstanding the available fault current.

RESIDENTIAL

The cooperative will design its facilities, where practicable, so that the maximum fault current will not be greater than 10,000 amperes-symmetrical at new single-family residences having service entrances nominally rated at 200 amperes or less. (There may be exceptions to this rule due to size and location of transformers, and also when serving townhouses, condominiums and apartments, consult with the cooperative in such cases.)

COMMERCIAL & INDUSTRIAL (600 AMPS & BELOW)

Table No. I specifies the minimum interrupting rating of service entrance equipment that shall be installed. In some cases, the available fault current may exceed these values and higher rated equipment may be required when the company elects to serve from a larger multiple service transformer. (See Table No. III)

TABLE NO. I

Current values shown are symmetrical amperes at the secondary terminals of the transformers.

Service Entrance Ampacity	Minimum Short Circuit Rating (AMPS)							
	Single Phase		Three Phase					
	120/240 V		120/208 V		277/480 V		120/240 V	
	Pole	Pad	Pole	Pad	Pole	Pad	Pole	Pad
200 or Less	13,000	10,700	13,000	21,700	11,300	12,400	11,300	N/A
400	26,000	20,000	26,000	21,700	22,500	23,600	22,500	N/A
600	41,000	31,300	39,000	41,800	35,500	24,300	34,000	N/A

N/A Not Available

COMMERCIAL & INDUSTRIAL (800 AMPERES & ABOVE)

Sometimes it is necessary to order switchgear before sufficient design data is available to make a detailed fault study. For this reason, the cooperative lists maximum fault tables that should permit the proper sizing of pre-ordered switchgear. Care must be exercised in using these tables. Table No. II gives maximum faults at the seconday bushing of the transformer. Table No. II may be used only when the cooperative will serve the section with a single transformer installation.

Example: A commercial enterprise has had a facility designed and the electrical engineer has determined that the SES will be 1,000 AMPS and the voltage will be 120/208 3ø. From Table No. II it can be found that the short circuit available is 52,100 for pole type transformers and 54,400 for pad type transformers.

TABLE NO. II

Current values shown are symmetrical amperes at the secondary terminals of transformers.

Service Entrance Equipment Capacity	Assumed SES Loading at 80% Capacity	3 ø 120/240 V		3 ø 120/208 V		3 ø 277/480 V	
		Pole	Pad	Pole	Pad	Pole	Pad
800	640	45,000	Not Available	39,000	41,800	35,500	24,300
1,000	800	66,100		52,100	54,400	47,500	24,300
1,200	960	70,800		81,700	56,100	47,500	24,300
1,600	1,280	70,800		81,700	56,100	54,700	24,300
2,000	1,600	95,000		81,700	56,100	75,300	31,500

COMMERCIAL & INDUSTRIAL

Table No. III shall be used when the cooperative serves the customer from a transformer with multiple services. This table can be used only when the ultimate size of the transformer is known. (Consult with the cooperative for that decision)

Example: A commercial enterprise is bding built in an existing shopping center where the electrical facilities are already established. The requirements are for a 400 AMP SES 277/480 V 3 ø. Verification with the cooperative reveals that a 500 KVA pad mounted transformer is already serving adjacent businesses and could accept this load. From Table No. III, after 500 KVA transformer, find the utility short circuit current available to be 24,3000 AMPS.

TABLE NO. III

Current values are symmetrical amperes at the secondary terminals of the transformer.

Transformer Bank KVA 1 ø or 3 ø	1 ø 120/240 V		3 ø 120/240 V		3 ø 120/208 V		3 ø 277/480 V		3 ø 240/480 V
	Pole	Pad	Pole	Pad	Pole	Pad	Pole	Pad	Pole
25	*	*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
37 ½	*	*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
50	13,000	13,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
75	19,500	19,500	11,300	N/A	13,00	10,420	*	*	*
100	26,000	26,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
122 ½	N/A	N/A	16,900	N/A	19,500	21,700	*	*	*
150	N/A	N/A	22,600	N/A	26,000	28,500	11,300	12,400	11,300
167	40,900	40,900	N/A	N/A	N/A	N/A	N/A	N/A	N/A
225	N/A	N/A	33,800	N/A	39,600	41,800	16,900	18,100	11,900
300	N/A	N/A	45,100	N/A	52,100	54,400	22,500	23,600	22,500
500	N/A	N/A	71,00	N/A	81,900	56,100	35,500	24,300	35,500
750	N/A	N/A	95,00	N/A	**	**	47,500	24,300	47,500
1000	N/A	N/A	N/A	N/A	**	**	54,700	24,300	54,700
1500	N/A	N/A	N/A	N/A	**	**	75,400	36,100	75,400

* Available short circuit current 10,000 AMPS or less

** Conlult with the cooperative

*** 3 ø transformer installations assume three equal sixe transformers. If transformers are not equal in size, use larger transformer and table for 3 transformers

N/A Not available