CHAPTER 2

ELECTRICAL POWER REQUIREMENTS

2-1. General.

The most feasible method of supplying and distributing electrical power will be determined by first quantifying the electrical power requirements (or maximum demand load) for the installation. In the early design stages, this demand should be based on area or population; in later design stages, summation of individual building connected loads modified by suitable demand and diversity factors will be used. For early stages, use of kW, kVA, and hp interchangeably on a one to one basis is sufficiently precise. During final design, hp will be converted to kVA; and kVA may be multiplied by the estimated power factor to obtain kW if required. The calculation of full load amperes will utilize kVA.

2-2. load Estimation.

Load estimation requires analysis of load characteristics and will take into account the demand factor relationship between connected loads and the actual demand imposed on the system.

a. Preliminary loads. The load data given in table 2-1 will be used to compute preliminary estimates of the expected maximum demands and electrical energy usage. These values allow computations to be made for either population or building area. Per capita loads are for an average daytime population.

b. Demand factor. Demand factors will be applied to connected loads when calculating the required ampacity of conductors, capacity of transformers, and all equipment associated with distribution of electrical power to utilization equipment. Realistic demand factors will be calculated in early design stages to provide an economical, cost effective system while insuring that items of equipment and materials are adequate to serve existing, new, and future load demands. Demand factors utilized in later design stages will document and reflect the number, the type, the duty rating (continuous, intermittent, periodic, short time, and varying), and the wattage or voltampere rating of equipment supplied by a common source of power, and the diversity of operation of equipment served by the common source. No more than ten percent spare capacity will be considered during design unless spare capacity is authorized by follow-on projects approved for construction in later years. Demand factor is defined as the ratio of the maximum demand (largest demand during a specified time period) to the total connected load.

c. Diversity factor. Diversity factors will be applied to the demand loads when calculating the required ampacity of service and feeder conductors, distribution transformers, and all other distribution system equipment. Typical diversity factors are given in table 2-2 and an illustration of their use is shown in a demand flow relationship in figure 2-1. This illustration indicates the load at substation “X” would be 1/2.24 or 0.45 times the summation of the demands based on the given data. Since utilities calculate loads on a less conservative basis, diversity factors for main electrical supply stations on military installations will

Table 2-1. Typical Demands and Usages.

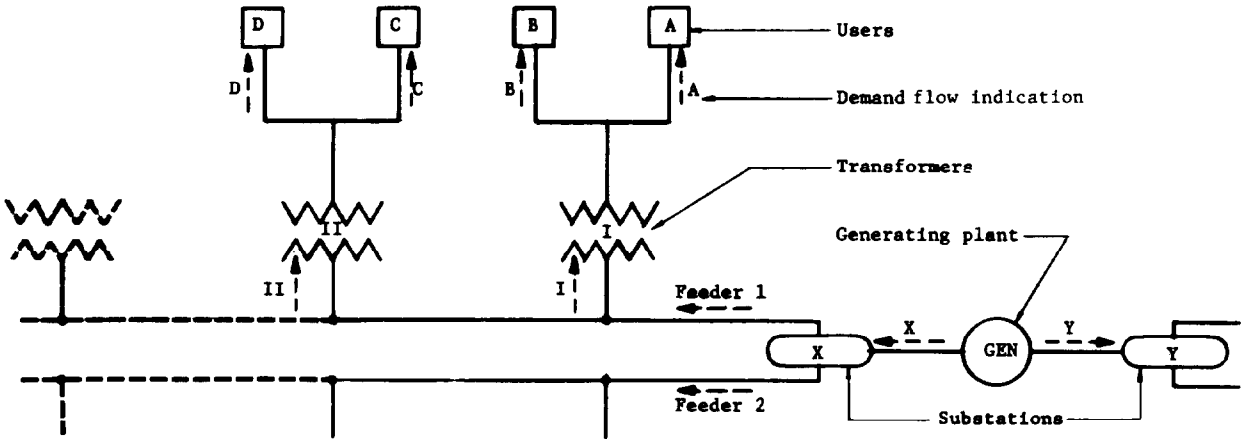
		Per capita		Per 1,000 square feet	
Service	Installation	Maximum demand kW	Usage per year kWh	Maximum demand kW	Usage per year kWh
Army Command	Development & Readiness	1.0-3.0	7,500-25,000	0.5-2	5,000-20,000
	Forces	0.5-1.2	3,000- 6,000	1-5	5.000-25.000
	Training & Doctrine	0.6-1.2	2,500- 7,500	1-3	5,000-20,000
Air Force Base	Logistics Command	1.5-2.5	7,000-10,000	2-4	10,000-20,000
	Military Airlift Command	1.0-2.5	5,000-10,000	2-3	5,000-15,000
	Tactical Air Command	0.5-2.0	3,000- 6,000	2-5	10,000-20,000
	Training	1.0-1.5	4,000- 6,000	2-5	10,000-20,000

*Table 2-2. Diversity Factors. **

Elements of system between which diversity factors are stated:	Diversity factors for Residence lighting	Commercial lighting	General power	Large users
Between individual users.	2.0	1.46	1.45	-
Between transformers.	1.3	1.3	1.35	1.05
Between feeders	1.15	1.15	1.15	1.05
Between substations	1.1	1.10	1.1	1.1
From users to transformer.	2.0	1.46	1.45	-
From users to feeder	2.6	1.90	1.95	1.15
From users to substation.	3.0	2.18	2.24	1.32
From users to generating station	3.29	2.40	2.46	1.45

*From "Standard Handbook for Electrical Engineers" by Fink and Beaty, copyright 1987, by McGraw-Hill, Inc. Used with permission of McGraw-Hill Book Company.

be higher than the 2.24 shown in figure 2-1 (lower than 0.45 demand). Diversity factor is defined as the ratio of the sum of the individual maximum demands of various subsystems within a system to the maximum demand of the system. The diversity of demands among transformers on a typical radial feeder makes the actual maximum load on the feeder less than the sum of the transformer loads.



ELECTRIC DEMAND FLOW DIAGRAM

ELECTRIC DEMAND FLOW RELATIONSHIPS[a]

1. Transformer I demand - (User(A + B)demands) / (User diversity factor)
   - [(A + B) / 1.45] - User loads / (1.45)
2. Feeder 1 demand - (Transformer I + II demands) / (Transformer diversity factor)
   - ([(A + B) / 1.45] + [(C + D) / 1.451) / 1.35 - User loads /(1.95)
3. Substation X demand - (Feeder 1 + 2 demands) / (Feeder diversity factor)
   - ([(Veer loads) /1.95] / 1.15) - User loads / (2.24)
4. Generating plant demand - (Substation X + Y demands) /(Substation diversity factor)
   - ([(User loads) /(2.24] / 1.10) - User loads /(2.46)

[a]Figures used are from general power column of table 2-2.

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Figure 2-1. Illustration of Diversity Factor Application.

d. Energy costs. An order of magnitude for energy costs will be computed as shown on figure 2-2 using population values from table 2-1. Cost comparisons have been simplified for clarity and do not include such items as fuel and power factor adjustment charges, "off-peak" or "on-peak" demands, or other billing practices used by utilities.

e. Load factor. Load factor is defined as the ratio of the average load over a designated period of time to the peak load occurring in that period. A low load factor indicates short-time demand peaks which can result in heavy charges to the Using Agency. Where the load factor is determined to be less than 0.40, for loads which will affect the utility demand charges, an engineering and economic analysis will be performed to determine the optimum method for correcting the deficiency. Low load factor will be corrected by shedding loads or by peak-shaving generation during periods of peak demand.

f. Family housing units. Demand factors for transformers serving family housing areas will comply with the guidance in appendix B.

Air Force Training Base

Assume:
Population = 9,000
Demand charge = $3.00 per kW of billing (maximum) demand
Energy charge = $0.025 per kWh

1. Maximum demand per month =
9,000 people x 1.3 kW per capita = 11,700 kW

2. Energy used per month =
(9,000 people x 4,000 kWh per year) ÷ 12 months = 3,000,000 kWh

3. Energy costs

a. Demand = 11,700 kW x $3.00 per kW = $ 35,100.
b. Energy = 3,000,000 kWh x $0.025 per kWh = $ 75,000.
Total monthly energy cost = $110,100.

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Figure 2-2. Monthly Electric Cost Computation.