An Introduction to Electric Power Requirements for Buildings

By

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CONTENTS

1. PRELIMINARY DATA

1.1 SCOPE. This discussion provides an introduction to the criteria necessary for the proper selection of electric power sources and distribution systems. It covers preliminary load estimating factors and electrical power sources.

1.2 LOAD DATA. Before specific electric power sources and distribution systems can be considered, realistic preliminary load data must be compiled. The expected electric power demand on intermediate substations, and on the main electric power supply, shall be calculated from the connected load layout by applying appropriate factors. Determine these factors by load analysis and by combining loads progressively. To combine the loads, start at the ends of the smallest feeders and work back to the electric power source. Because all loads must be on a common kilowatt (kW) or kilovolt-ampere (kVA) basis, it is necessary to convert motor horsepower ratings to input kilowatts or kilovolt-amperes before combining them with other loads already expressed in those terms. Preliminary electric power load estimates can be made by using the approximate value of one kilovolt-ampere of input per horsepower (hp) at full load. Preliminary estimates of lighting loads may be made by assuming watts per ft^2 of building area.

1.3 LOAD ANALYSIS. To determine appropriate load estimating factors, using the tables and factors in this manual as guides to analyze the characteristics of each load. Consider items such as environmental conditions of weather, geographical location, and working hours, as the situation dictates. Notice that when the load densities in w/ft^2 are used only in preliminary estimates, the demand and load factors will be used in the final designs.

1.4 TERMINOLOGY. Five terms are essential to the analysis of load characteristics: demand factor, coincidence factor, diversity factor, and maximum demand. These terms are defined below.

1.4.1 DEMAND FACTOR. The demand factor is the ratio of the maximum demand on a system to the total connected load of the system or

EQUATION: Demand factor = $\frac{\text{Maximum demand load}}{\text{Total load connected}}$

1.4.2 COINCIDENCE FACTOR. The coincidence factor is the ratio of the maximum demand of a system, or part under consideration, to the sum of the individual maximum demands of the subdivisions or

EQUATION: Coincidence factor = $\frac{\text{Maximum system demand}}{\text{Sum of individual maximum demands}}$

1.4.3 DIVERSITY FACTOR. The diversity factor is the reciprocal of the coincidence factor or

EQUATION: Diversity factor = $\frac{\text{Sum of individual maximum demands}}{\text{Maximum system demand}}$

1.4.4 LOAD FACTOR. The load factor is the ratio of the average load over a designated period of time, usually 1 year, to the maximum load occurring in that period or

EQUATION: Load factor = $\frac{\text{Average load}}{\text{Maximum load}}$

1.4.5 MAXIMUM DEMAND. The maximum demand is the integrated demand for a specified time interval, i.e., 5 minutes, 15 minutes, 30 minutes, or other appropriate time intervals, rather than the instantaneous or peak demand.

2. ESTIMATION OF LOADS

2.1 PREPARATION OF LOAD DATA. Load data are generally computed in steps such as:

a) individual loads,
b) area loads, and
c) activity loads.

A particular design problem may be limited to step a), to steps a) and b), or may encompass steps a), b), and c). This section outlines each step as a separate entity, dependent only on previous steps for data.

2.2 INDIVIDUAL LOADS. Individual loads are those with one incoming service supplying utilization voltage to the premises. In general, these loads would comprise single structures. Large structures could contain more than one function. Under this condition, factors that have been developed and (refer to Table 2.1) would be used.

2.2.1 LIGHTING. To eliminate lighting loads, divide a facility area into its significant components by function (for example, office, storage, mechanical, and corridor). Determine the average lighting level and type of light source for each area. Consider requirements for supplementary lighting (for example, floodlighting, security lighting, and special task lighting). Preliminary load estimates may be made based on the following load allowances:

a) 1 W/sf for each 6 to 8 fc of incandescent illumination.
b) 1 W/sf for each 15 to 20 fc of fluorescent illumination.
c) 1 W/sf for each 12 to l8 fc of mercury vapor illumination.
d) 1 W/sf for each 26 to 36 fc of metal halide illumination.
e) 1 W/sf for each 33 to 54 fc of high pressure sodium illumination.

2.2.2 SMALL APPLIANCE LOADS. Small appliance loads shall include those served by general purpose receptacles. In general, the dividing of areas by function for estimating lighting loads will serve for estimating small appliance loads. The determination of loads requires not only knowledge of the function of an area, but to what extent its occupants use small appliances. For example, an office area demand may average about 1 W/sf but could vary from a low of 0.5 W/sf to a high of 1.5 W/sf depending on the specific tasks to be performed. A minimum of 0.1 W/sf for auditoriums to a maximum of 2.5 W/sf for machine shops is possible, although the upper limit would occur very rarely. Mechanical spaces in building storage areas and similar spaces in which outlets are provided but infrequently used are usually neglected in computing loads, except for special cases.

2.2.3 ELECTRIC POWER LOADS. Electric power loads shall include all loads other than lighting loads and those served by general purpose receptacles and comprise the environmental system electric power requirements and the facility occupancy equipment electric power requirements.

2.2.4 SYSTEM LOSS. A system loss of approximately 6 percent, based on calculated maximum demand, should be added to the building load.

2.2.5 DEMAND AND LOAD FACTORS. The demand and load factors for a specific facility will vary with the division of load and hours of usage. Refer to Tables 2.2 and 2.3 for values that can be applied to determine demand and load factors. Table 2.4 is included as a guide and an aid in illustrating the method of determining loads, which are calculated for a particular type of building. The values given are empirical and will vary from activity to activity, and may vary from one facility to another within an activity. Annual hours use of demand must be determined for each case in accordance with methods of operation and characteristics of the installation. Such factors should be used for quick estimating purposes and as a check when a more precise calculation is undertaken (refer to Table 2.4).

2.2.5.1 Guides for Demand Factors. For guides on the selection of demand factors, refer to Table 2.5.

2.2.5.2 Guides for Load Factors. Guides for the selection of load factors indicate the need for special considerations (refer to Table 2.6).

2.2.6 LOAD GROWTH. Determine the requirements for load growth for anticipated usage and life expectancy with particular attention to the possibility of adding heavy loads in the form of air conditioning, electric heating, electric data processing, and electronic communication equipment. Before determining the size of service and method of distribution to a facility, an economic analysis shall be made to determine the most feasible way of serving this future load. This analysis shall include the effect on the existing installation if future loads require reinforcing or rehabilitation of the service system.

Table 2.1 Factors for Individual Facilities		
	Demand Factor	Load Factor
Communications – buildings	60-65	70-75
Telephone exchange building	55-70	20-25
Air passenger terminal building	65-80	28-32
Aircraft fire and rescue station	25-35	13-17
Aircraft line operations building	65-80	24-28
Academic instruction building	40-60	22-26
Applied instruction building	35-65	24-28
Chemistry and Toxicology Laboratory	70-80	22-28
Materials Laboratory	30-35	27-32
Physics Laboratory	70-80	22-28
Electrical and electronics systems laboratory	20-30	3-7
Cold storage warehouse	70-75	20-25
General warehouse	75-80	23-28
Controlled humidity warehouse	60-65	33-38
Hazardous/flammable storehouse	75-80	20-25
Disposal, salvage, scrap building	35-40	25-20
Hospital	38-42	45-50
Laboratory	32-37	20-25
Dental Clinic	35-40	18-23
Medical Clinic	45-50	20-23
Administrative Office	50-65	20-35
Single-family residential housing	60-70	10-15
Detached garages	40-50	2-4
Apartments	35-40	38-42
Fire station	25-35	13-17
Police station	48-53	20-25
Bakery	30-35	45-60
Laundry/dry cleaning plant	30-35	20-25
K-6 schools	75-80	10-15
7-12 schools	65-70	12-17
Churches	65-70	5-25
Post Office	75-80	20-25
Retail store	65-70	25-32
Bank	75-80	20-25
Supermarket	55-60	25-30
Restaurant	45-75	15-25
Auto repair shop	40-60	15-20
Hobby shop, art/crafts	30-40	25-30
Bowling alley	70-75	10-15
Gymnasium	70-75	20-45
Skating rink	70-75	10-15
Indoor swimming pool	55-60	25-50
Theater	45-55	8-13
Library	75-80	30-35
Golf clubhouse	75-80	15-20
Museum	75-80	30-35

TYPES OF LOADS	ESTIMATED RANGE OF DEMAND FACTOR (%)	QUICK ESTIMATING DEMAND FACTOR (%)
MOTORS:		
General purpose, machine tool, cranes, elevators, ventilation, compressors, pumps, etc.	20 - 100	30
MOTORS:		
Miscellaneous, fractional, and small appliances	10 - 50	25
Resistance ovens, heaters, and furnaces	80 - 100	80
Induction furnaces	80 - 100	80
Lighting	65 - 100	75
Arc welders	25 - 50	30
Resistance welders	5 - 40	20
Air-conditioning equipment	60 - 100	70
Refrigeration compressors	40 - 100	60

Note 1: Demand factors include allowance for system loss.

Table 2.2
Demand Factors for Specific Loads

TYPES OF LOADS	QUICK ESIMATING HOURS USE		
	1-SHIFT OPERATION	2-SHIFT OPERATION	3-SHIFT OPERATION
MOTORS:			
General purpose	1,200	1,600	2,000
MOTORS:			
Miscellaneous, fractional, and small appliances	1,500	1,800	2,100
Resistance ovens, heaters, and furnaces .	1,000	1,300	1,600
Induction furnaces	900	1,200	1,500
Lighting	2,200	2,800	3,500
Arc welders	500	700	900
Resistance welders	500	700	900
Air-conditioning equipment			
Less than 1,500 cooling degree days ...	1,200	1,400	1,600
1,500 to 1,500 cooling degree days	1,600	1,800	2,000
More than 2,500 cooling degree days ...	2,200	2,500	2,800

Table 2.3
Annual Hours of Demand Usage for Specific Loads

	MOTORS				
	GENERAL	MISCEL-LANEOUS FRAC-TIONAL & SMALL APPLI-ANCES	LIGHTING	AIR CONDI-TIONING	TOTAL
1. Watts/square foot	1.0	1.0	2.7	4.5	9.2
(Watts/square meter)	10	10	26.5	45	91.5
2. Connected load	100 kw	100 kw	265 kw	450 kw	915 kw
3. Specific load demand factor	30%	10%	75%	70%	
4. Maximum demand load (line 2 X line 3)	30 kw	10 kw	200 kw	315 kw	555 kw
5. Annual operating (1-shift) usage	1,200 hrs	1,500 hrs	2,200 hrs	1600 hrs	
6. Annual usage in megawatt hours (line 4 X line 5)	36	15	440	504	995
7. Demand factor Formula (1) = $\frac{\text{line 4}}{\text{line 2}}$	—	—	—	—	60%
8. Load factor Formula (4) = $\frac{\text{line 6}}{\text{line 4 X 8760 hrs}}$	—	—	—	—	20%

Note 1: Calculated for a 100,000 square-foot (10,000 square meter) building. See tables 2 and 3 for data used for lines 3 and 5 respectively. Load growth is included in connected load. Maximum demand load includes allowance for system loss. For this illustration, the coincidence factor occurring when individual demand loads are added is considered to be 1.00 and has not been shown.

Table 2.4
Academic Building Demand and Load Factor Calculations

Selection of factors in upper half of range for conditions described below	Selection of factors in lower half of range for conditions described below
GENERAL GUIDES	
Facilities in active use and approaching maximum capacity. Loads predominantly lighting. Loads predominantly heating. Loads dominated by one or two large motors.	Facilities of intermittent use or not being fully utilized. Motor loads made up of a number of independently operated small motors. Motor loads controlled automatically unless control depends upon weather conditions.
OPERATIONAL AND TRAINING FACILITIES	
Instruction buildings with little or no electric equipment. Communications buildings with telephonic equipment only.	Large instruction buildings with electrical demonstration and training equipment.
MAINTENANCE AND PRODUCTION FACILITIES	
Shops and facilities when engaged in mass production of similar parts.	No special guides.
RESEARCH, DEVELOPMENT, AND TEST FACILITIES	
Facilities used for repetitive testing of material or equipment.	No special guides.
SUPPLY FACILITIES	
Refrigerated warehouses in South. Dehumidified warehouses in Mississippi Valley and along seacoasts. Warehouses for active storage.	Warehouses with many items of electric materials handling equipment, including cranes and elevators.
HOSPITAL AND MEDICAL FACILITIES	
No special guides.	No special guides.

Table 2.5
Guides for Selection of Demand Factors

ADMINISTRATIVE FACILITIES	
Large administrative buildings with mechanical ventilation and air conditioning. Note: Group large administrative buildings separately only when administration is a significant part of total activity load.	Casual offices, offices used infrequently by foremen and supervisors, or offices in which there is little prolonged desk work.

HOUSING AND COMMUNITY FACILITIES	
Enlisted barracks at training centers. Public quarters where less than 25 family units are involved. Restaurants, exchanges, cafeterias, and other food service facilities when gas or steam is primary fuel.	Food service facilities where load is primarily cooking and baking.

UTILITIES AND GROUND IMPROVEMENTS	
Central heating plants serving extended areas and buildings. Water pumping stations serving extended areas or carrying most of load of water systems. Central station compressed air plants.	No special guides.

Table 2.5 (continued)
Guides for Selection of Demand Factors

Select factors in upper half of range conditions described below	Select factors in lower half of range for conditions described below
GENERAL GUIDES	
Facilities operated on two or more shifts.	Facilities used intermittently.
Loads that are primarily fluorescent or high intensity discharge lighting.	Inactive facilities.
Many small independently operated motors.	Large motor loads when the load consists of relatively small numbers of motors.
Electronic equipment continuously operated for immediate use.	Wholesale-type service facilities.
Cooling and dehumidification loads for year-round climate control in southern climates.	
Retail-type service loads and loads that are in active use.	
OPERATIONAL AND TRAINING FACILITIES	
Large, permanent instruction buildings in active use.	Special-purpose instruction and training facilities not regularly used.
MAINTENANCE AND PRODUCTION FACILITIES	
Shops with battery charging equipment operated after hours.	Welding loads or loads made up primarily of welding equipment.
Active shops at full employment.	Job-order workshops.
Mass production shops.	Shops with large, heavy special function machines.
	Large induction or dielectric heating loads.
RESEARCH, DEVELOPMENT, AND TEST FACILITIES	
No special guides.	No special guides.

Table 2.6
Guides for Selection of Load Factors

SUPPLY FACILITIES	
Refrigerated and dehumidified warehouses in South or in humid climates. Warehouses for active storage and in continuous use.	Refrigerated warehouses in North. Warehouses with large materials handling equipment loads.
HOSPITAL AND MEDICAL FACILITIES	
Clinics and wards with daily operating hours and in active use.	No special guides.
ADMINISTRATIVE FACILITIES	
Large, active, well-lighted offices with ventilation and air-conditioning equipment.	No special guides.
HOUSING AND COMMUNITY FACILITIES	
Navy exchanges with food service facilities. Gymnasiums used in connection or with physical therapy. Barracks at schools and training centers.	Restaurants and exchanges serving only one meal a day. Restaurants and exchanges with gas steam food preparation equipment. Chapels used primarily on Sundays. Subsistence buildings serving less than four meals a day. Laundries with dry cleaning plants. Exchanges operated less than 8 hrs/day. Gatehouses operated less than 24 hrs/day.
UTILITIES AND GROUND IMPROVEMENTS	
Heating plants that supply both heating and process steam. Water plants with little power load. Air-conditioning plants for year-round control of environment in South. Compressed air plants consisting of many banked compressors operating automatically.	Heating plants in South.

Table 2.6 (continued)
Guides for Selection of Load Factors

2.3 EMERGENCY LOADS. The determination of emergency electric power requirements is based on three types of loads:

a) minimum essential load,
b) emergency load for vital operations, and
c) uninterruptible (no-break) load.

When the three categories of emergency electric power requirements have been ascertained, determine where local emergency facilities are required, where loads may be grouped for centralized emergency facilities, and what loads are satisfied by the reliability of the general system. Base the aforementioned determinations on safety, reliability, and economy, in that order.

2.4 AREA LOADS. Area loads consist of groups of individual facility loads served by a subdivision of the electric distribution system. The term "area" applies to the next larger subdivision of an overall distribution system. Demand loads for an area must be known for sizing the distribution wiring and switching, and in a large installation will be required for the design of substations serving the area. Table 2.7 gives an example of how the coincident peak demand is calculated.

2.4.1 GENERAL LOADS. To obtain the general load, add roadway lighting, area lighting, obstruction lighting, and other loads not included in individual facility loads.

2.4.2 COINCIDENCE FACTOR. Determine the maximum expected demands, taking into consideration whether loads within the area peak at the same or at different times.

2.4.2.1 Relationships. Figure 2.1 indicates the relationship that exists between the load factor of individual facility loads and the coincidence of their peak demands with the peak demand of the group. Table 2.8 is Figure 2.1 in tabular form with values shown to the nearest whole dollar, except for low load factors.

2.4.2.2 Selection. Areas with relatively insignificant residential type loads, where the load curve indicates that most of the electric power consumed in the area is used during the 40 normal working hours of a week, have coincidence factors at the higher end of the range.

2.4.2.3 Electric Power Consumption. In general, areas where large amounts of electric power are consumed outside the usual 40 working hours a week have a coincidence factor at the lower end of the range (examples are hospitals, areas operated on two or more shifts, or large barracks type activities). The upper limit of the range is for a 40 hour per week operation; the lower limit is for a 60 hour per week operation.

DESCRIPTION	TOTAL CONNECTED LOAD (kW)	DEMND FACTOR (%)	MAXIMUM DEMAND (%)	LOAD FACTOR (%)	COINCIDENCE FACTOR (%)	COINCIDENCE PEAK (kW)
Fuel oil pump house.....						
Fuel oil pump house.....						
Total	0.3	100	0.3	52	52(1)	0.2
Filling station	3.0	60	1.8	18	57(1)	1.0
Filling station bldg .	0.3	80	0.2	20	61(1)	0.1
Receiver building	2.1	65	1.4	72	79	1.1
Transmitter building.....						
Transmitter building.....						
Total	37.2	65	24.2	72	79	19.1
Tacan building	0.7	65	0.5	72	79	0.4
Radar building	1.2	70	0.8	72	79	0.6
Aircraft fire and rescue station	8.0	30	2.4	15	52(1)	1.2
Aircraft operations building	80.2	80	64.2	28	68(1)	43.6
Photographic building	10.5	70	7.4	18	57(1)	4.2
Academic instruc. bldg.....						
Academic instruc. bldg.....						
Academic instruc. bldg.....						
Academic instruc. bldg.....						
Total	47	60	28.2	22	62(1)	17.5
Operational Trainer facility	0.1	80	0.1	15	52(1)	....
Aircraft overhaul and repair shop	7,600	38	2,890	25	95(2)	2,745
Paint/finishing hangar	127	70	89.0	26	66(1)	58.3
Engine preparation and storage shop.....						
Engine maint. shop.....						
Engine maint. shop.....						
Total	405	40	162	15	52(1)	84.2
Engine test cell	360	45	162	28	68(1)	110
Missile equipment maint. shop	3.0	40	1.2	22	62(1)	0.7
Auto veh. maint. facs.....						
Auto veh. maint. facs.....						
Auto veh. maint. facs.....						
Auto veh. maint. facs.....						
Total	370	60	222	25	65(1)	145

Table 2.7

730	10	Fire station	14.6	30	4.4	15	521	2.3
					Total			3,325
					System loss (6%)			194
					Grand total			3,429

(1) The coincidence factor has been increased to allow for low load factor and number of facilities in the area. Refer to para. 2.3.2.4, Influencing Factors, of this handbook.

(2) The coincidence factor has been increased because of the relative magnitude of the load. Refer to para. 2.3.2.5, Individual Loads, of this handbook.

Table 2.7 (continued)
Method of Calculating Coincident Peak Demand

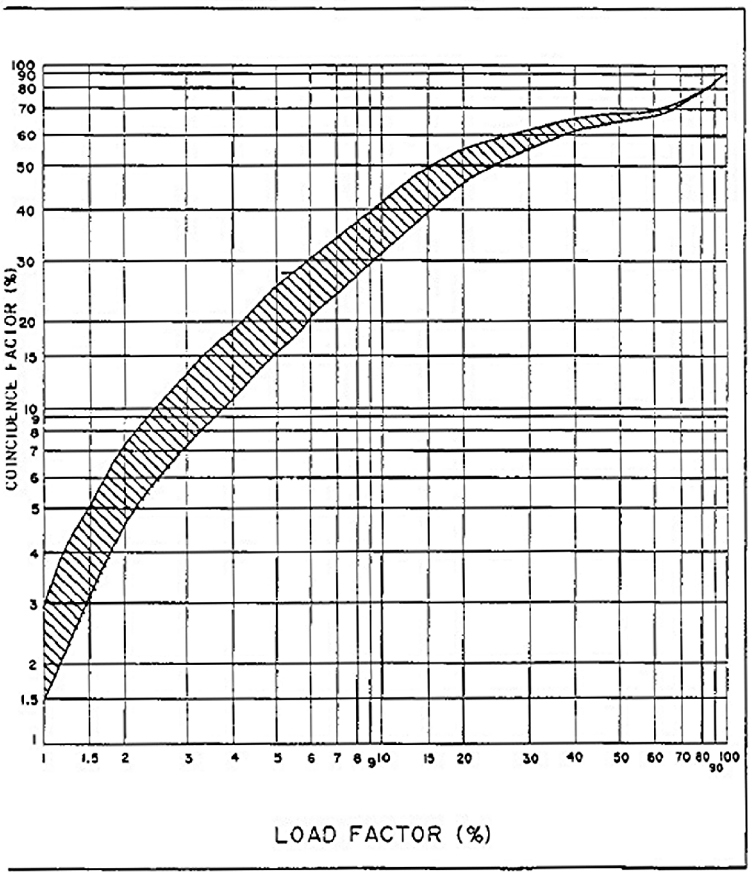

Figure 2.1
Theoretical Relationship Between Load Factor and Coincidence Factor

LOAD FACTOR (%)	COINCIDENCE FACTOR (%) Loads (hr/wk) 40	60	LOAD FACTOR (%)	COINCIDENCE FACTOR (%) LOADS (hr/wk) 40	60
1	2.5	1.5	51	73	69
2	7.5	4.5	52	73	70
3	12	8	53	73	70
4	17	11	54	73	70
5	21	14	55	73	71
6	25	17	56	73	71
7	28	20	57	73	71
8	32	22	58	74	71
9	35	24	59	74	72
10	38	26	60	74	72
11	41	29	61	74	72
12	44	32	62	75	73
13	46	34	63	75	73
14	49	36	64	76	74
15	51	38	65	76	74
16	53	40	66	77	75
17	54	42	67	77	75
18	56	44	68	78	76
19	57	46	69	78	76
20	59	48	70	78	77
21	60	50	71	78	77
22	61	51	72	79	78
23	62	53	73	79	78
24	63	54	74	80	79
25	64	55	75	81	80
26	65	56	76	81	80
27	66	56	77	82	81
28	67	57	78	82	81
29	68	58	79	82	81
30	69	59	80	82	82
31	69	60	81	82	82
32	69	61	82	82	82
33	70	62	83	83	83
34	70	63	84	84	84
35	71	64	85	85	85
36	71	64	86	86	86
37	71	65	87	87	87
38	71	65	88	88	88
39	72	65	89	89	89
40	72	66	90	90	90
41	72	66	91	91	91
42	72	66	92	92	92
43	72	67	93	93	93

Table 2.8
Relationship Between Load Factor and Coincidence Factor

LOAD FACTOR (%)	COINCIDENCE FACTOR (%) Loads (hr/wk) 40	60	LOAD FACTOR (%)	COINCIDENCE FACTOR (%) LOADS (hr/wk) 40	60
44	73	67	94	94	94
45	73	67	95	95	95
46	73	67	96	96	96
47	73	68	97	97	97
48	73	68	98	98	98
49	73	69	99	99	99
50	73	69	100	100	100

Table 2.8 (continued)
Relationship Between Load Factor and Coincidence Factor

their load factors influence the individual load coincidence factor. The coincidence factors in Table 8 apply for groups of l00 or more individual loads. These coincidence factors can also be used for groups of as few as 30 to 50 individual loads if their load factor is 0.30 or greater. For areas of fewer individual loads, the mathematical relationship from IEEE Technical Paper 45-116 provides a basis for estimating the connected coincidence factor as shown by the following equation:

EQUATION: $E_n = E_t + (1-E_t)\ 1/n$

Where:

E_n = The individual load coincidence factor applied with a given number of consumers

E_t = the coincidence factor as given in Table 8 in hundredths.

n = the number of individual loads in a group.

2.4.2.4 Individual Loads. The coincidence factors in Table 8 are based on the individual loads in a group being substantially the same size. If a single load or small group of loads in an area represents a substantial percentage of overall load, the coincidence factors as given in Table 8 will no longer apply. With an individual load,

increase the coincidence factor to a value commensurate with its effect on the overall area load. This is not in addition to, but in place of, the normal coincidence factor. Determine this value by considering intergroup coincidence factors given in paragraph

2.4.2.5. For a small group, determine the coincidence peak load, and to this apply the appropriate intergroup coincidence factor to obtain the coincidence peak load for the area.

2.4.2.6 Groups of Loads or Areas. Where groups of loads within an area, or areas within a facility are combined, an additional intergroup coincidence factor will exist. For loads of a similar nature, the intergroup coincidence factor should be in the range 0.93 to 1.00. If loads of a varying nature (evening loads and daytime loads) are combined, the intergroup coincidence factor should be in the range of 0.70 to 1.00. The lower values will occur when the magnitudes of the loads are nearly balanced, and the higher ones when the combined load is predominantly one type.

2.4.3 LOAD GROWTH. In addition to planned expansion, increased application of electric equipment will generate an increase in load. When sizing components, such as transformers or feeders for the area system, consider possible load growth in addition to that included in the determination of individual loads.

2.4.4 SYSTEM LOSSES. Add distribution system losses to estimated area demands. For a good approximation, use 6 percent of the calculated maximum demand.

2.4.5 EMERGENCY LOADS. Review the overall emergency requirements for the area, based on criteria for the facility or as furnished by the using agency, to determine the following:

a) The emergency loads that may be combined in groups to take advantage of the coincidence factor.

b) The type of distribution system needed for reliability and to economically satisfy at least the less critical emergency load requirements.
This reliability can be provided only if the source of electric power is not the determining factor.
c) Area loads that must be added to individual emergency loads; for example, security lighting and minimum roadway lighting.

2.4.6 EXPANSION. The planned development of the area, as shown on the activity general development map, shall be considered for requirements of future expansion.

2.5 ACTIVITY LOADS. Activity loads are loads that consist of two or more area loads served from a single electric power source and an integrated distribution system.

2.5.1 GENERAL LOADS. Area loads used for determining activity coincidence demand should be the area coincident demand exclusive of allowance for load growth.

2.5.2 COINCIDENCE FACTOR. Where dissimilar areas, whether residential, administrative, or industrial, are part of an activity, make a careful analysis of the coincidence factor used.

2.5.3 LOAD GROWTH. As for an area, components should be sized after due consideration has been given to load growth. Apply this increase to the coincident demand of the activity.

2.5.4 EXPANSION. The planned development of the activity, as shown on its general development map, shall be considered for requirements of future expansion.

3. SELECTION OF ELECTRIC POWER SOURCE

3.1 ELECTRIC POWER SOURCES. The electric power supply for a major development usually will consist of three sources: primary, standby, and emergency (alternate). In

many situations the only practicable option is purchasing power from the local electric utility. In other situations, however, there may be alternatives. In addition, some operations cannot tolerate any electric power interruption, thus requiring uninterruptible power supply (UPS) systems.

3.1.1 PRIMARY. The primary or preferred source should have sufficient capacity to provide for peak electric power demand during normal peacetime operations.

3.1.2 STANDBY. The standby source should have enough capacity so that the standby system can supply all of the minimum essential operating electric load of the activity and, when added to the capacity of the primary source, will provide a combined capacity sufficient to serve the estimated peak demand under mobilization conditions. This "minimum essential operating electric load" is the minimum electric power necessary to support the absolutely essential operations of the activity, with illumination reduced to a bare minimum and with all convenience loads and other loads (such as hospital elevators, except the minimum required for patient and food transportation) suspended. Where major intermittent loads, such as electric furnaces, electric welders, and wind tunnels, are involved, it is necessary to determine whether concurrent operation of such equipment can be avoided.

3.1.3 EMERGENCY. The emergency sources, usually one or more engine-driven, manual, or automatic-starting emergency generators, should have sufficient total capacity to provide the electric power demand for vital operations. Vital operations are those that can tolerate electric power interruption only for relatively short durations. For certain operations, the permissible electric power interruption is as long as 4 hours, for others it is only l0 seconds. The latter condition will require automatic start but the former condition may be manual start. The emergency source should be of sufficient capacity to provide a continuous and adequate supply for vital operations, but should be planned to bear a sound relation to the standby service provided. Vital operations will normally be in two categories:

a) Operations recognized by local, state, or national codes, and

b) Operations determined as vital by the major claimant or user.

To qualify as a vital operation, the electric power outages must cause loss of primary missions, thus resulting in disastrous situations or extreme safety hazards as compared to minor disruption and inconvenience. Such vital operations may include, but are not necessarily limited to, communications, ventilation, and lighting of combat operations centers, personnel bomb shelters, anti-aircraft, harbor defenses, industrial processes that might cause explosion if interrupted, hospital surgeries, blood banks, bone banks, iron lungs, and similar operations.

3.1.4 UNINTERRUPTIBLE (NO-BREAK) ELECTRIC POWER. An Uninterruptible Power Supply (UPS) system is necessary for certain electronic or other equipment that perform a critical functions and require continuous, disturbance-free electric power to operate properly. This electric power system must, under all conditions, provide regulated electric power to the critical load.

3.2 ACCEPTABLE ELECTRIC POWER SOURCES.

3.2.1 PRIMARY. The primary source of electric power may be customer-owned generating equipment or one or more feeders from an outside electric power system.

3.2.2 STANDBY. Where the primary source of electric power is customer-owned generation, the standby source may be other customer-owned generation or service supplied over a feeder, or feeders, from an outside electric power supplier. Where the primary source of electric power is from an outside electric power supplier, the standby source may be customer-owned generation or service supplied over a feeder, or feeders, from a different outside electric power supplier or supply from an alternate feeder from the same outside electric power supplier. The alternate feeder must be located at some distance from the normal feeder, and supplied independently of the substation and generating source of the normal feeder. Where this is not feasible, a

supply from transmission lines or substations of the outside electric power supplier, which themselves have dual supplies, is an acceptable alternative.

3.2.3 EMERGENCY. Permanently installed, mobile or semi-mobile, manual or automatic starting generating equipment should be provided to supply emergency electric power. Emergency generating capacity should not exceed the minimum required to supply electric power for vital operations, and should be located as close to those loads as practicable. Provisions for normal load growth (15 to 20 percent spare capacity) shall be provided. As a minimum, the provisions of NFPA 110 Emergency and Standby Power Systems, shall apply.

3.2.4 UNINTERRUPTIBLE (NO-BREAK) ELECTRIC POWER. Permanently installed, automatically operated equipment should be provided to supply uninterruptible electric power. Equipment capacity should not exceed the minimum required to supply electric power for critical loads, and equipment should be located as close to these loads as practicable. Provision for normal load growth (15 to 20 percent spare capacity) shall be provided.

3.3 PURCHASED ELECTRIC POWER REQUIREMENTS.

3.3.1 ADEQUACY. Determine the capability of the electric utility company to furnish electric power, of the required characteristics, to meet the immediate estimated demand. The capability of the utility to meet the demand should be determined on the best basis available. Ascertain whether or not the utility has enough construction in its program to meet the loads anticipated for the next 5 years.

3.3.2 RELIABILITY. Investigate the history of outages of the contemplated utility company to determine if it can provide the degree of reliability required by the particular installation. The investigation shall include the following items:

a) A 5-year history of service outages in the area, including:

(1) The time and date of each occurrence

(2) Duration, time, and date of each restoration

(3) Cause

(4) Steps taken to restore service and

(5) A probability analysis showing the expected number of outages of 1 minute, 5 minutes, 10 minutes, 30 minutes, and 60 minutes.

b) A one-line diagram of the supplier's system, showing the location of all switching equipment, circuit breakers, relaying, and similar components.

c) A short circuit study of the system, including interrupting capacities of all switching equipment, time constants, and short circuit currents for both existing and expanded facilities in the area.

d) Voltage regulation, nominal voltage, and normal operating voltage of supplier's facilities.

e) Climatic and other physical conditions prevailing in the area and on the system that may affect the reliability of service. Some utilities will only supply a minimum of data for items a) to c), and evaluation may be necessary using data available from other installations in the area.

3.3.3 RATES. To take advantage of the lowest available cost of electric energy, compare electric energy rates with estimated maximum demand and consumption. Compare the estimated demand block with prices per kilowatt-hour of other customers served by the same utility company. Choice of either primary or secondary connection shall be based on selection of connection charges and rental of company equipment that provide the maximum advantage. An analysis of rates shall be based on the company's complete tariff covering all types of services. This review will entail

comparison of several tariffs that are available on an alternative basis, as well as the general rules and regulations that modify the tariffs.

3.3.4 PRIMARY SERVICE RIGHT-OF-WAY. The supply company should provide the right-of-way for all of its electric lines.

3.3.5 PRIMARY SUBSTATIONS

3.3.5.1 Voltage. A substation may not be required where the utility company serves energy at 13.8 kV or less; distribution may be at this voltage. In some cases, if the loads are large enough, distribution may be done at higher voltage up to a maximum of 35 kV.

3.3.5.2 Economics. Usually, ownership of main substations serving an activity is determined by engineering and economic factors. Distribution system voltages, as well as amortization costs of substations, should be the controlling factors.

QUIZ

An Introduction to
Electric Power Requirements for Buildings

1. Preliminary electric power load estimates for motors can be made by using the approximate value of _____ kilovolt-ampere of input per horsepower (hp) at full load.

   a. four
   b. three
   c. two
   d. one

2. The _____ factor is the ratio of the maximum demand on a system to the total connected load of the system.

   a. diversity
   b. coincidence
   c. load
   d. demand

3. The _____ factor is the ratio of the maximum demand of a system, or part under consideration, to the sum of the individual maximum demands of the subdivisions

   a. diversity
   b. coincidence
   c. load
   d. demand

4. The _____ factor is the reciprocal of the coincidence factor.

   a. diversity
   b. coincidence
   c. load
   d. demand

5. The _____ factor is the ratio of the average load over a designated period of time, usually 1 year, to the maximum load occurring in that period.

a. diversity
b. coincidence
c. load
d. demand

6. The maximum demand is the _____ demand for a specified time interval, i.e., 5 minutes, 15 minutes, 30 minutes, or other appropriate time intervals, rather than the instantaneous or peak demand.

a. integrated
b. coincident
c. derivative
d. estimated

7. Preliminary lighting load estimates for incandescent illumination may be made based on _____.

a) 1 W/sf for each 6 to 8 fc
b) 1 W/sf for each 15 to 20 fc
c) 1 W/sf for each 12 to l8 fc
d) 1 W/sf for each 26 to 36 fc
e) 1 W/sf for each 33 to 54 fc

8. Preliminary lighting load estimates for high pressure sodium illumination may be made based on _____.

a) 1 W/sf for each 6 to 8 fc
b) 1 W/sf for each 15 to 20 fc
c) 1 W/sf for each 12 to l8 fc
d) 1 W/sf for each 26 to 36 fc
e) 1 W/sf for each 33 to 54 fc

9. Preliminary lighting load estimates for fluorescent illumination may be made based on _____.

a) 1 W/sf for each 6 to 8 fc
b) 1 W/sf for each 15 to 20 fc
c) 1 W/sf for each 12 to l8 fc
d) 1 W/sf for each 26 to 36 fc
e) 1 W/sf for each 33 to 54 fc

10. Preliminary lighting load estimates for mercury vapor illumination may be made based on _____.

a) 1 W/sf for each 6 to 8 fc
b) 1 W/sf for each 15 to 20 fc
c) 1 W/sf for each 12 to l8 fc
d) 1 W/sf for each 26 to 36 fc
e) 1 W/sf for each 33 to 54 fc

11. For electric power estimating purposes for a church building, a Load Factor of _____% would be reasonable.

a. 55
b. 45
c. 35
d. 25

12. For electric power estimating purposes for a church building, a Demand Factor in the range of _____ % would be reasonable.

a. 75 - 80
b. 65 - 70
c. 55 - 60
d. 45 - 50

13. For electric power estimating purposes for a supermarket building, a Demand Factor in the range of _____ % would be reasonable.

a. 75 - 80
b. 65 - 70
c. 55 - 60
d. 45 - 50

14. For electric power estimating purposes for a supermarket building, a Load Factor in the range of _____ % would be reasonable.

a. 55 - 60
b. 45 - 50
c. 35 - 40
d. 25 - 30

15. For electric power estimating purposes for a single family residential house, a Load Factor in the range of _____ % would be reasonable.

a. 40 - 45
b. 30 - 35
c. 20 - 25
d. 10 - 15