APPENDIX C

CIRCUIT ARRANGEMENTS

(Informative)

C1 SCOPE

This Appendix provides guidance on the following factors that determine the arrangement of circuits in an installation that would be deemed to meet the design, equipment selection and installation criteria of this Standard:

(a) Determination of the circuit current for consumers mains, submains and final subcircuits.

(b) Cable selection based on current-carrying capacity and voltage drop.

(c) Coordination of current ratings of circuit cables and protective devices.

(d) Division of installation into circuits supplying single and multiple items of equipment, as necessary, to provide satisfactory performance of circuits for purpose intended.

(e) Cable installation guides.

C2 MAXIMUM DEMAND

C2.1 After diversity maximum demand

As indicated in Clause 2.5 (and explained in Paragraph B3.2), the current in a circuit must not exceed the current rating of the circuit protective device, which, in turn, must not exceed the current-carrying capacity of the circuit conductors.

For circuits supplying a single item of equipment, the circuit current is simply the nominal load current of the equipment, e.g., a 10000 W 230/400 V three-phase heater has a full per–phase load current of 14.5 A. The circuit conductors and the protective device must have a current-carrying capacity of not less than 16 A (nearest standard rating).

Where more than one item of equipment is connected, the circuit current could be simply assessed as the sum of the individual equipment load currents. While this would provide a safe and conservative solution, it does not take account of the normal operating conditions during which all equipment is not operating simultaneously at full load or for long periods, e.g. submains to a distribution board associated with numerous socket-outlet circuits. Under such conditions the circuit current is estimated using diversity factors and is often described as the ‘after diversity maximum demand’.

The diversity factors applicable to any given circuit in an installation will depend on a number of features of the installation including—

(a) conditions under which the installation is expected to be used, e.g. residential compared with commercial; and

(b) operating characteristics of the connected load, e.g. airconditioning load in tropical locations compared with heating loads in cold-climate regions; and

(c) number and physical distribution of points provided on the circuit, e.g. socket-outlets provided for convenient connection of portable equipment compared to dedicated or fixed equipment loads; and

(d) size and type of significant loads, e.g. large motors or industrial plant.

It should be recognized that the determination of diversity factors is not accurate for every installation and different installations of the same type may have significantly different load profiles which the designer needs to consider. The methods provided herein have been used over several editions of AS/NZS 3000 and, provided that care is taken to assess the presence of unusual equipment loads, are considered appropriate for many typical applications.

When the load is assessed and the current-carrying capacity of the circuit is determined by allowing for diversity of operation of equipment, then the circuit should be protected by a circuit-breaker of rating to comply with Paragraph B3.2.

C2.2 Calculation of maximum demand in consumers mains and submains

As stated in Clause 2.2.2, maximum demand current can be determined by one of four methods—calculation, assessment, measurement or limitation. The following paragraphs of this Appendix provide information and examples on the application of the calculation method for determining maximum demand current in consumers mains and submains only.

C2.3 Domestic installations

C2.3.1 *Method*

Table C1 provides an allocation of load for different types of equipment connected to consumers mains or submains in a single or multiple domestic installation. The load current is calculated for each equipment load group in the installation or affected part thereof, and these contributions are added together to achieve the maximum demand current. The accompanying notes provide clarification of certain provisions and the examples demonstrate how the calculation is made.

TABLE C1

MAXIMUM DEMAND—SINGLE AND MULTIPLE DOMESTIC ELECTRICAL INSTALLATIONS

1	2	3	4	5
Load group	**Single domestic electrical installation or individual living unit per phase[a]**	**Blocks of living units[a,b,c]**		
		2 to 5 living units per phase	**6 to 20 living units per phase**	**21 or more living units per phase**
		Loading associated with individual units		
A. Lighting (i) Except (ii) and load group H below [d,e]	3 A for 1 to 20 points + 2 A for each additional 20 points or part thereof	6 A	5 A + 0.25 A per living unit	0.5 A per living unit
(ii) Outdoor lighting exceeding a total of 1000 W [f,g]	75% connected load	No assessment for the purpose of maximum demand		
B. (i) Socket-outlets not exceeding 10A[e,h]. Permanently connected electrical equipment not exceeding 10 A and not included in other load groups[i]	10 A for 1 to 20 points + 5 A for each additional 20 points or part thereof	10 A + 5 A per living unit	15 A + 3.75 A per living unit	50 A + 1.9 A per living unit
(ii) Where the electrical installation includes one or more 15 A socket-outlets, other than socket-outlets provided to supply electrical equipment set out in groups C,D, E, F, G, and L[h,j]	10 A			
(iii) Where the electrical installation includes one or more 20 A socket-outlets other than socket-outlets provided to supply electrical equipment set out in groups C, D, E, F, G, and L[h,j]	15 A			

(*continued*)

TABLE C1 (*continued*)

1	2	3	4	5
Load group	**Single domestic electrical installation or individual living unit per phase[a]**	**Blocks of living units[a,b,c]**		
		2 to 5 living units per phase	**6 to 20 living units per phase**	**21 or more living units per phase**
		Loading associated with individual units		
C. Ranges, cooking appliances, laundry equipment or socket-outlets rated at more than 10 A for the connection thereof [h]	50% connected load	15 A	2.8 A per living unit	
D. Fixed space heating or airconditioning equipment, saunas or socket-outlets rated at more than 10 A for the connection thereof [h,k]	75% connected load	75% connected load	75% connected load	
E. Instantaneous water heaters[l]	33.3% connected load	6 A per living unit		100 A + 0.8 A per living unit
F. Storage water heaters[m]	Full-load current	6 A per living unit		100 A + 0.8 A per living unit
G. Spa and swimming pool heaters	75% of the largest spa, plus 75% of the largest swimming pool, plus 25% of the remainder			

(*continued*)

TABLE C1 (*continued*)

1	2	3	4	5
Load group	**Single domestic electrical installation or individual living unit per phase[a]**	**Loading not associated with individual units—connected to each phase (communal lighting, laundry loadings, lifts, motors, etc.)**		
H. Communal lighting[f,g]	Not applicable	Full connected load		
I. Socket-outlets not included in groups J and M below[h,j,n]. Permanently connected electrical equipment not exceeding 10 A	Not applicable	2 A per point, up to a maximum of 15 A		
J. Appliances rated at more than 10 A and socket-outlets for the connection thereof— (i) Clothesdryers, water heaters, self-heating washing machines, wash boilers[h]	Not applicable	50% connected load		
(ii) Fixed space heating, airconditioning equipment, saunas[k]	Not applicable	75% connected load		
(iii) Spa and swimming pool heaters	Not applicable	75% of the largest spa plus 75% of the largest swimming pool, plus 25% of the remainder		
K. Lifts	In accordance with Paragraph C2.4.1 and Table C2	In accordance with Paragraph C2.4.1 and Table C2		
L. Motors	In accordance with Paragraph C2.4.1,and Table C2, Column 2	In accordance with Paragraph C2.4.1 and Table C2, Column 2		
M Appliances, including socket-outlets other than those set out in groups A to L above, e.g. pottery kilns, welding machines, radio transmitters, X-ray equipment and the like	Connected load 5 A or less: No assessment for purpose of maximum demand	Connected load 10 A or less: No assessment for purpose of maximum demand		
	Connected load over 5 A: By assessment	Connected load over 10 A: By assessment		

NOTES TO TABLE C1:

a See Clause 2.2.2 for where the maximum demand for consumers mains, and submains, and final subcircuits, respectively, may be determined by assessment, measurement or limitation.

b For multiphase connections, divide the number of living units by the number of supply phases, e.g. 16 units on a three-phase supply, 16/3 = 6 units on the heaviest loaded phase (Column 4).

c Where only a portion of the number of units in a multiple domestic electrical installation is equipped with permanently connected or fixed appliances, such as electric cooking ranges or space heating equipment, the number of appliances in each category is divided over the number of phases, and the maximum demand determined as shown in Example 3 of Paragraph C2.3.2.

d Lighting track systems shall be regarded as two points per metre of track.

e A socket-outlet installed more than 2.3 m above a floor for the connection of a luminaire may be included as a lighting point in load group A(i).

An appliance rated at not more than 150 W, which is permanently connected, or connected by means of a socket-outlet installed more than 2.3 m above a floor, may be included as a lighting point in load group A(i).

f In the calculation of the connected load, the following ratings shall be assigned to lighting:

(i) *Incandescent lamps* 60 W or the actual wattage of the lamp to be installed, whichever is the greater, except that if the design of the luminaire associated with the lampholder permits only lamps of less than 60 W to be inserted in any lampholder, the connected load of that lampholder shall be the wattage of the highest rated lamp that may be accommodated. For multi-lamp luminaires, the load for each lampholder shall be assessed on the above basis.

(ii) *Fluorescent and other discharge lamps* Full connected load, i.e. the actual current consumed by the lighting arrangement, including the losses of auxiliary equipment, such as ballasts and capacitors.

(iii) *Lighting tracks (230 V)* 0.5 A/m per phase of track or the actual connected load, whichever is the greater.

g Floodlighting, swimming pool lighting, tennis court lighting and the like.

h For the purpose of determining maximum demand, a multiple combination socket-outlet shall be regarded as the same number of points as the number of integral socket-outlets in the combination.

i Each item of permanently connected electrical equipment not exceeding 10 A may be included in load group B(i) as an additional point.

j Where an electrical installation contains 15 A or 20 A socket-outlets covered by load group B(ii) or B(iii), the base loading of load group B is increased by 10 A or 15 A respectively. If both 15 A and 20 A socket-outlets are installed, the increase is 15 A.

k Where an electrical installation includes an airconditioning system for use in hot weather and a heating system for use in cool weather, only the system that has the greater load shall be taken into account.

l Instantaneous water heaters including ‘quick recovery’ heaters having element ratings greater than 100 W/L.

m Storage-type water heaters, including ‘quick recovery’ heaters not referred to in footnote *l*.

n This load group is not applicable to socket-outlets installed in communal areas but connected to the individual living units. Such socket-outlets should be included in load group B.

TABLE C2
MAXIMUM DEMAND – NON-DOMESTIC ELECTRICAL INSTALLATIONS

1	2	3
Load group	**Residential institutions, hotels, boarding houses, hospitals, accommodation houses, motels[a]**	**Factories, shops, stores, offices, business premises, schools and churches[a]**
A. Lighting other than in load group F[b,c]	75% connected load	Full connected load
B. (i) Socket-outlets not exceeding 10 A other than those in B(ii)[c,e]	1000 W for first outlet plus 400 W for each additional outlet	1000 W for first outlet plus 750 W for each additional outlet
(ii) Socket-outlets not exceeding 10 A in buildings or portions of buildings provided with permanently installed heating or cooling equipment or both[c,d,e]	1000 W for first socket-outlet, plus 100 W for each additional outlet	
(iii) Socket-outlets exceeding 10 A[c,e]	Full current rating of highest rated socket-outlet, plus 50% of full current rating of remainder	Full current rating of highest rated socket-outlet plus, 75% of full current rating of remainder
C. Appliances for cooking, heating and cooling, including instantaneous water heaters, but not appliances included in groups D and J below	Full connected load of highest rated appliance, plus 50% of full load of remainder	Full connected load of highest rated appliance, plus 75% of full load of remainder
D. Motors other than in E and F below	Full load of highest rated motor, plus 50% of full load of remainder	Full load of highest rated motor, plus 75% of full load of second highest rated motor, plus 50% of full load of remainder
E. Lifts	(i) Largest lift motor – 125% full load (ii) Next largest lift motor – 75% full load (iii) Remaining lift motors – 50% full load For the purpose of this load group, the full-load current of a lift motor shall mean the current taken from the supply when lifting maximum rated load at maximum rated speed	
F. Fuel dispensing units	(i) Motors: First motor – full load Second motor – 50% full load Additional motors – 25% full load (ii) Lighting – full connected load	

(*continued*)

TABLE C2 (*continued*)

1	2	3
Load group	**Residential institutions, hotels, boarding houses, hospitals, accommodation houses, motels[a]**	**Factories, shops, stores, offices, business premises, schools and churches[a]**
G. Swimming pools, spas, saunas, thermal storage heaters including water heaters, space heaters, and similar arrangements	Full-load current	
H. Welding machines	In accordance with Paragraph C2.5.2, taking into account power factor correction	
J. X-ray equipment	50% of the full load of the largest X-ray unit, additional units being ignored	
K. Other equipment not covered by load groups above	By assessment	

NOTES:

a See Clause 1.6.3 for where the maximum demand for consumers mains, submains, and final subcircuits, respectively, may be determined by assessment, measurement or limitation.

b In the calculation of the connected load, the following ratings shall be assigned to lighting:

(i) *Incandescent lamps* 60 W or the actual wattage of the lamp to be installed, whichever is the greater, except that if the design of the luminaire associated with the lampholder permits only lamps of less than 60 W to be inserted in any lampholder, the connected load of that lampholder shall be the wattage of the highest rated lamp which may be accommodated. For multi-lamp luminaires, the load for each lampholder shall be assessed on the above basis.

(ii) *Fluorescent and other discharge lamps* Full connected load, i.e. the actual current consumed by the lighting arrangement, having regard to auxiliary equipment, such as ballasts and capacitors.

(iii) *Lighting tracks* 0.5 A/m per phase of track or the actual connected load, whichever is the greater.

c A socket-outlet installed more than 2.3 m above a floor for the connection of a luminaire may be included as a lighting point in load group A.

An appliance rated at not more than 150 W, which is permanently connected, or connected by means of a socket-outlet installed more than 2.3 m above a floor, may be included as a lighting point in load group A.

d Load group B (ii) applies to an electrical installation, or portion of an electrical installation, incorporating permanently installed heating and/or cooling equipment specifically provided to render unnecessary the use of socket-outlets for portable electric space heating or cooling appliances. Whether heating or cooling or both is deemed necessary to avoid the use of portable heating or cooling equipment will depend on the location and climate involved.

e For the purpose of determining maximum demand, a multiple combination socket-outlet shall be regarded as the same number of points as the number of integral socket-outlets in the combination.