APPENDIX C
CIRCUIT ARRANGEMENTS
(Informative)

C1 SCOPE

This Appendix provides guidance on the following:

(a) Determination of the circuit current for consumer 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 the purpose intended.

(e) Cable installation.

These are the factors that determine the arrangement of circuits in an installation that is deemed to meet the design, equipment selection and installation criteria of this Standard.

C2 MAXIMUM DEMAND

C2.1 After diversity maximum demand

As indicated in Clause 2.5.3, the current in a circuit is not permitted to exceed the current rating of the circuit protective device, which, in turn, is not permitted to exceed the current-carrying capacity of the circuit conductors.

NOTE: Paragraph B3.2 of Appendix B explains further.

For circuits supplying a single item of equipment, the circuit current is simply the nominal load current of the equipment, e.g. a 10 000 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 are required to 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 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’.

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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;

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

(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 given in this Appendix will not be 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 this Standard 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 conform with Paragraph B3.2 of Appendix B.

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

As specified in Clause 2.2.2, maximum demand current may be determined by one of four methods—calculation, assessment, measurement or limitation. The following paragraphs provide information on and examples of the application of the calculation method for determining maximum demand current in consumer 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 consumer 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 ensuing examples demonstrate how the calculation is made.

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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[1]	Blocks of living units[1, 2, 3]		
		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) Lighting except (ii) and load group (h) below[4, 6]	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[6, 7]	75% connected load	No assessment for the purpose of maximum demand		
(b) (i) Socket-outlets not exceeding 10 A[5, 8]. Permanently connected electrical equipment not exceeding 10 A and not included in other load groups[9]	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 load groups (c), (d), (e), (f), (g) and (l)[8, 10]	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 load groups (c), (d), (e), (f), (g) and (l)[8, 10]	15 A			

(continued)

WELCOME TO THE JUNGLE GOAT FUCKERS

TABLE C1 (*continued*)

1	2	3	4	5
Load group	**Single domestic electrical installation or individual living unit per phase**[1]	**Blocks of living units**[1, 2, 3]		
		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[8]	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[8, 11]	75% connected load	75% connected load	75% connected load	
(e) Instantaneous water heaters:[12]	33.3% connected load	6 A per living unit		100 A + 0.8 A per living unit
(f) Storage water heaters[13]	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			
(h) Communal lighting[6, 7]	Not applicable	Full connected load		
(i) Socket-outlets not included in load groups (j) and (m) below[8, 10, 14] Permanently connected electrical equipment not exceeding 10 A	Not applicable	2 A per point, up to a maximum of 15 A		

(*continued*)

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TABLE C1 (*continued*)

1	2	3	4	5
		Blocks of living units[1, 2, 3]		
Load group	**Single domestic electrical installation or individual living unit per phase[1]**	**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		
(j) Appliances rated at more than 10 A and socket-outlets for the connection thereof—				
(i) Clothes dryers, water heaters, self-heating washing machines, wash boilers[8]	Not applicable	50% connected load		
(ii) Fixed space heating, airconditioning equipment, saunas[11]	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		
* (iv) Charging equipment associated with electric vehicles	Fully connected load	100% connected load	90% connected load	75% connected load
(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 load 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:

1 See Clause 2.2.2 for the circumstances where the maximum demand for consumer mains, submains, and final subcircuits, may be determined by assessment, measurement or limitation.

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

3 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 Paragraph C2.3.2.3.

4 Lighting track systems are regarded as two points per metre of track.

5 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).

6 In the calculation of the connected load, the following ratings are assigned to lighting:

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

(b) *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.

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

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

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

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

10 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.

11 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 is taken into account.

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

13 Storage-type water heaters, including ‘quick recovery’ heaters not covered by Note 12.

14 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).

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C2.3.2 *Examples of calculation*

NOTE: These examples were calculated assuming a supply voltage and electrical equipment rating of 230 V.

C2.3.2.1 *Example 1*

Problem:

To determine the maximum demand of a single domestic electrical installation supplied at single-phase with the following load:

24	lighting points
10 m	of lighting track
9	10 A single socket-outlets
8	10 A double socket-outlets
1	50 W exhaust fan
1	1000 W strip heater
1	15 A socket-outlet
1	10 000 W range
1	4800 W water heater
1	3000 W tennis court lighting

Solution:

The method of determining demand in accordance with Table C1 is as follows:

Load group (a)(i)—

24 lighting points; plus

10 m of lighting track; plus

50 W exhaust fan = 45 points

= 3 + 2 + 2 = 7 A.

Load group (a)(ii)—

3000 W tennis court lighting = 13 × 0.75 = 9.8 A.

Load group (b)(i)—

9 × 10 A single socket-outlets; plus

8 × 10 A double socket-outlets = 25 points

1000 W strip heater = 1 point

= 10 + 5 = 15 A.

Load group (b)(ii)—

15 A socket-outlet = 10 A.

Load group (c)—

10 000 W range = 43.48 × 0.5 = 21.7 A.

Load group (f)—

Water heater 4800 W = 20.9 A.

Total demand = Sum of load group demands = (a)(i) + (a)(ii) + (b)(i) + (b)(ii) + (c) + (f)

= 7 + 9.8 + 15 + 10 + 21.7 + 20.9

= 84.4 A

C2.3.2.2 *Example 2*

Problem:

To determine the maximum demand of the heaviest loaded phase in a domestic electrical installation comprising—

26 lighting points

24 10 A single-phase single socket-outlets

1 15 A single-phase socket-outlet

1 16 600 W three-phase electric range consisting of two 5000 W hotplates and one 6600 W oven

1 4000 W single-phase airconditioning unit

1 12 960 W three-phase instantaneous water heater

1 3600 W single-phase clothes dryer

and arranged for connection across a three-phase supply as follows:

Red	***White***	***Blue***
15 A socket-outlet 5000 W hotplate 4000 W airconditioner	5 × 10 A socket-outlets 5000 W hotplates	9 × 10 A socket-outlets 6600 W oven
4320 W instantaneous water heater	4320 W instantaneous water heater 3600 W clothes dryer	4320 W instantaneous water heater

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Solution:

The method of determining the demand in the heaviest loaded phase, in accordance with Table C1 is as follows:

Equipment	***Load group***	***Column***	***Red A***	***White A***	***Blue A***
Lighting	(a)(i)	2			5
10 A socket-outlets	(b)(i)	2		10	10
15 A socket-outlet	(b)(ii)	2	10		
Range	(c)	2	10.9	10.9	14.4
Airconditioner	(d)	2	13.0		
Water heater	(e)	2	6.3	6.3	6.3
Clothes dryer	(c)	2		7.8	
			40.2	35.0	35.7

Total loading, heaviest loaded phase = red phase, 40.2 A.

C2.3.2.3 *Example 3*

Problem:

To determine the maximum demand of the heaviest loaded phase of a block of 80 units comprising the following loads:

Lighting	80 units.
10 A single-phase socket-outlets	80 units.
Single-phase electric ranges	17 units.
2500 W (10.9 A) permanently connected single-phase strip heaters	80 units.
Single-phase quick recovery water heaters	80 units.

Loading not associated with the individual units (communal services):

Communal area lighting and power:

90	60 W lighting points
21	100 W lighting points
	(total lighting 7500 W)
20	10 A single-phase single socket-outlets
10	3600 W single-phase clothes dryers
2	12 000 W three-phase lift motors (22 A per phase nameplate rating)
1	5500 W three-phase pump motor (10.4 A per phase nameplate rating)

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1 4000 W three-phase water supply motor (8.3 A per phase nameplate rating)

Solution:

The method of determining the demand of the heaviest loaded phase, assuming that the electrical installation is balanced as far as practicable over the three phases, in accordance with Table C1, is as follows:

(a) Number of units per phase, three-phase supply = 80/3 = 27 units over each of two phases and 26 units on the other phase. The instructions given in Column 5 of Table C1 would therefore be applicable to the electrical installation other than for the electric ranges.

(b) The number of electric ranges per phase = 17/3 = 6 over each of two phases and 5 on the other phase. The instructions in Column 4 of Table C1 would therefore be applicable to the load group (c), ranges and cooking appliances.

Individual units (27 units):

Equipment	***Load group***	***Column***	***Calculation***	***Result***
Lighting	(a)(i)	5	27 × 0.5	= 13.5 A
Socket-outlets	(b)(i)	5	50 + (27 × 1.9)	= 101.3 A
Electric ranges (6 units)	(c)	4	6 × 2.8	= 16.8 A
Strip heaters	(d)	5	27 × 10.9 × 0.75	= 220.7 A
Water heaters	(f)	5	100 + (27 × 0.8)	= 121.6 A
Total units loading for heaviest loaded phase				= 473.9 A

Communal services:

The lighting is taken as being evenly balanced over the phases, i.e. 7500/3 = 2500 W per phase. [Should the lighting load be arranged for connection to one phase, the loading for load group (h) would be 7500 W.]

The 20 socket-outlets are taken as connected, seven over each of two phases and six on the other phase.

The 10 clothes dryers are taken as connected, three over each of two phases and four on the other phase—loading on heaviest loaded phase = 14 400 W.

The two 12 000 W lift motors = 22 A per phase (nameplate rating)

Motors: 5500 W motor = 10.4 A per phase (nameplate rating)

4000 W motor = 8.3 A per phase (nameplate rating)

Equipment	***Load group***	***Column***	***Calculation***		***Result***
Lighting	(h)	5	$\frac{2500}{230}$	=	10.9 A
Socket-outlets	(b)	5	7×2	=	14.0 A
Clothes dryers	(j)(i)	5	$0.5\left(\frac{14\,400}{230}\right)$	=	31.3 A
Lifts	(k)	5	$(22 \times 1.25) + (22 \times 0.75)$	=	44.0 A
Motors	(l)	5	$10.4 + (8.3 \times 0.5)$	=	14.6 A
Total communal services loading for heaviest loaded phase				=	114.8 A

Total loading for heaviest loaded phase:

= units loading + communal services loading

= 473.9 + 114.8 = 588.7 A.

C2.4 Non-domestic installations

C2.4.1 *Method*

Table C2 provides an allocation of load for different types of equipment connected to consumer mains or submains in a non-domestic installation. The load current is calculated for each equipment load group in the installation, or affected part thereof, and these contributions are then added together to achieve the maximum demand current. The accompanying notes provide clarification of certain provisions and the ensuing examples demonstrate how the calculation is made.

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TABLE C2

MAXIMUM DEMAND—NON-DOMESTIC ELECTRICAL INSTALLATIONS

1	2	3
Load group	**Residential institutions, hotels, boarding houses, hospitals, accommodation houses, motels**[1]	**Factories, shops, stores, offices, business premises, schools and churches**[1]
(a) Lighting other than in load group (f)[2]	75% connected load	Full connected load
(b) (i) Socket-outlets not exceeding 10 A other than those in (b)(ii)[3,5]	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[3,4,5]	1000 W for first socket-outlet, plus 100 W for each additional outlet	
(iii) Socket-outlets exceeding 10 A[3,5]	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) (i) Appliances for cooking, heating and cooling, including instantaneous water heaters, but not appliances included in load 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
* (ii) Charging equipment associated with electric vehicles	Full connected load of highest rated appliance, plus 75% 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 means the current taken from the supply when lifting maximum rated load at maximum rated speed	

(*continued*)

TABLE C2 (*continued*)

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

NOTES:

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

2 In the calculation of the connected load, the following ratings are assigned to lighting:

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

(b) *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.

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

3 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).

NOTES TO TABLE C2 (*continued*)

4 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.

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

C2.4.2 *Examples of calculation*

C2.4.2.1 *Example 4*

Problem:

To determine the maximum demand of the heaviest loaded phase of a 30-unit motel complex supplied by three-phase with the following load:

200	60 W lighting points
30	50 W single-phase exhaust fans (permanently connected)
10	10 A single-phase single socket-outlets (non-permanently heated or cooled area)
90	10 A single-phase single socket-outlets (permanently heated or cooled area)
4	15 A single-phase socket-outlets
1	16 600 W three-phase electric range consisting of two 5000 W hotplates and one 6600 W oven
1	750 W three-phase sewerage pump motor (2.0 A per phase nameplate rating)
1	6000 W single-phase sauna heater

The load is arranged for connection across the three-phase supply as follows:

Red	***White***	***Blue***
70 lights 10 exhaust fans	70 lights 10 exhaust fans	60 lights 10 exhaust fans
5 × 10 A socket-outlets (b)(i)	5 × 10 A socket-outlets (b)(i)	
30 × 10 A socket-outlets (b)(ii)	30 × 10 A socket-outlets (b)(ii)	30 × 10 A socket-outlets (b)(ii)
1 × 15 A socket-outlet 6600 W oven 750 W pump	2 × 15 A socket-outlets 5000 W hotplates 750 W pump	1 × 15 A socket-outlet 5000 W hotplates 750 W pump 6000 W sauna

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Solution:

The method of determining the demand in the heaviest loaded phase in accordance with Table C2, Column 2 is as follows:

Equipment	*Load group*	*Calculation*	*Red A*	*White A*	*Blue A*
70 light points	(a)	$\frac{70 \times 60\ \text{W}}{230} \times 0.75$	13.7	13.7	
60 light points	(a)	$\frac{60 \times 60\ \text{W}}{230} \times 0.75$			11.74
10 exhaust fans	(a) [see Note 3 to Table C1]	$\frac{10 \times 50\ \text{W}}{230} \times 0.75$	1.63	1.63	1.63
5 × 10 A socket-outlets	(b)(i)	$1\,000 + (4 \times 400\ \text{W}) = \frac{2600\ \text{W}}{230}$	11.3	11.3	
30 × 10 A socket-outlets	(b)(ii)	$1\,000 + (29 \times 100\ \text{W}) = \frac{3900\ \text{W}}{230}$	16.96	16.96	16.96
1 × 15 A socket-outlet	(b)(iii)	Full current rating	15.0		15.0
2 × 15 A socket-outlets	(b)(iii)	15 A + (15 A × 0.5)		22.5	
6600 W oven	(c)	Full connected load	28.7		
5000 W hotplate	(c)	Full connected load		21.74	21.74
750 W sewer pump	(d)	Full load (nameplate rating)	2.0	2.0	2.0
6000 W sauna heater	(g)	Full-load current			26.09
			89.29	89.83	95.16

Total loading, heaviest loaded phase = blue phase, 95.16 A.

C2.4.2.2 *Example 5*

Problem:

To determine the maximum demand of the heaviest loaded phase of a factory electrical installation supplied by three-phase with the following load:

30 Twin 36 W power factor corrected fluorescent luminaires each with a run current of 0.42 A or as specified by the supplier

10 10 A single-phase single socket-outlets (non-permanently heated or cooled area)

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4	10 A single-phase double socket-outlets (permanently heated or cooled area)
1	20 A single-phase socket-outlet
1	15 A single-phase socket-outlet
1	4000 W single-phase airconditioner
1	5500 W three-phase rolling machine motor (10.4 A per phase nameplate rating)
1	4000 W three-phase lathe motor (8.3 A per phase nameplate rating)
1	3600 W single-phase storage water heater
2	250 A output three-phase arc welders (permanently connected) (10 A per phase primary current nameplate rating)
1	30 000 VA two-phase spot welder (permanently connected)—varying operation [Paragraph C2.5.2.3(a)(i)] (50 A per phase primary current nameplate rating)
1	15 000 VA two-phase spot welder (permanently connected)—specific operation at 20% duty cycle [Paragraph C2.5.2.3(a)(ii)] (25 A per phase primary current nameplate rating)

The load is arranged for connection across the three-phase supply as follows:

Red	***White***	***Blue***
15 lights 5 × 10 A socket-outlets (b)(i)		15 lights 5 × 10 A socket-outlets (b)(i)
	4 × 10 A socket-outlets (b)(ii)	
3600 W water heater		
15 A socket-outlet	20 A socket-outlet	
		4000 W airconditioner
5500 W rolling machine	5500 W rolling machine	5500 W rolling machine
4000 W lathe	4000 W lathe	4000 W lathe
250 A arc welder	250 A arc welder	250 A arc welder
250 A arc welder	250 A arc welder	250 A arc welder
	30 000 VA spot welder	30 000 VA spot welder
15 000 VA spot welder	15 000 VA spot welder	

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Solution:

The method of determining the demand in the heaviest loaded phase in accordance with Table C2, Column 3 is as follows:

Equipment	*Load group*	*Calculation*	*Red A*	*White A*	*Blue A*
Lighting	(a)	15×0.42 A	6.3		6.3
10 A socket-outlets	(b)(i)	$1\,000 + (4 \times 750\text{ W}) = \frac{4000\text{ W}}{230}$	17.39		17.39
10 A socket-outlets (double)	(b)(ii)	$1\,000 + (7 \times 100\text{ W}) = \frac{1700\text{ W}}{230}$		7.39	
20 A socket-outlet	(b)(iii)	Full current rating		20.0	
15 A socket-outlet	(b)(iii)	Full current rating	15.0		
4000 W airconditioner	(c)	Full connected load			17.39
5500 W rolling machine	(d)	Full load (nameplate rating)	10.4	10.4	10.4
4000 W lathe	(d)	75% full load (nameplate rating) 0.75×8.3	6.2	6.2	6.2
3600 W water heater	(g)	Full-load current	15.65		
250 A output arc welder 250 A output arc welder	(h)	100% of rated primary current each (nameplate rating)— Paragraph C2.5.2.2(b)(i)	10.0 10.0	10.0 10.0	10.0 10.0
30 000 VA spot welder [varying operation, Paragraph C2.5.2.3(a)(i)]	(h)	Manually operated, non-automatic—50% of the rated primary current (nameplate rating). $0.5 \times 50 = 25$ A Groups: Paragraph C2.5.2.3(b) Largest machine—full value obtained from Paragraph C2.5.2.3(a)(i)		25.0	25.0
15 000 VA spot welder [duty cycle 20% Paragraph C2.5.2.3(a)(ii)]	(h)	Multiplier for 20% duty cycle is $0.45 \times$ actual primary current for duty cycle selected (nameplate). $0.45 \times 25 = 11.25$ A Groups: Paragraph C2.5.2.3(b) Other machines—60% of value obtained from Paragraph C2.5.2.3(a)(ii) i.e. 0.6×11.25	6.8	6.8	
			97.74	95.79	102.68

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Total loading, heaviest loaded phase = blue phase, 102.68 A.

C2.4.3 *Alternative calculation method for commercial and light-industrial applications*

C2.4.3.1 *General*

The alternative calculation method set out below may be used for commercial and light-industrial applications. This method is based on experience and energy consumption figures for different types of occupancy within installations.

The values shown in Table C3 depend on factors such as the climate, occupancy hours and levels, energy management systems, and the degree to which equipment is uniformly distributed in the affected area.

An example is provided to demonstrate how the energy demand figures are converted to demand current.

C2.4.3.2 *Example*

A tenancy submains supplies an office of 1500 m^2 in a temperate location that uses a dedicated airconditioning plant with zonal electric reheat in cooler months. Table C3 gives a figure of 50 VA/m^2 for general light and power and 50 VA/m^2 for airconditioning. The total figure is 150 kVA (1500 m^2 $\times$ 100 VA/m^2), which equates to approximately 217 A at a 230/400 V operating voltage.

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TABLE C3

MAXIMUM DEMAND—ENERGY DEMAND METHOD FOR NON-DOMESTIC INSTALLATIONS

Type of occupancy		Energy demand	
		Range, VA/m²	Average, VA/m²
Offices	Light and power	40–60	50
	Airconditioning:		
	— Cooling	30–40	35
	— Reverse cycle	20–30	25
	— Zonal reheat	40–60	50
	— Variable volume	20	20
* Carparks	Open air	0–10	5
	EV charging	5–15	10
	Basement	10–20	15
	EV charging	10–30	20
Retail shops	Light and power	40–100	70
	Airconditioning	20–40	30
Warehouses	Light and power	5–15	10
	Ventilation	5	5
	Special equipment	(use load details)	
Light industrial	Light and power	10–20	15
	Ventilation	10–20	15
	Airconditioning	30–50	40
	Special equipment	(use load details)	
Taverns, licensed clubs	Total	60–100	80
Theatres	Total	80–120	100

NOTE: EV charging relates to charging equipment associated with electric vehicles and should be considered in addition to all other energy demands.

* C2.4.4 *Alternative method using switchboard diversity*

For switchboards conforming with the AS/NZS 3439 series or the AS/NZS 61439 series, the maximum demand may be determined by multiplying the arithmetic sum of the circuit overload ratings by the appropriate diversity factor in Table C4 below.

* **TABLE C4**

UPSTREAM CIRCUIT LOADING AFTER DIVERSITY

Number of circuit-protection devices downstream	Diversity factor
2 and 3	0.9
4 and 5	0.8
6 to 9	0.7
10 or more	0.6

C2.5 Maximum demand in final subcircuits

C2.5.1 *General*

The maximum demand in final subcircuits is determined—

(a) for single items of equipment, by assessment of the connected load; or

(b) for multiple items of equipment, by limitation of the current rating of a circuit-breaker.

NOTE: Table C9 provides guidance on the loading of points per final subcircuit.

In some applications, the connected equipment may operate in a particular manner that allows for diversity to be applied. This includes welding machines (see Paragraph C2.5.2), domestic cooking appliances (Paragraph C2.5.3) and interlocked equipment (Paragraph C2.5.4).

C2.5.2 *Welding machines*

C2.5.2.1 *Definitions*

For the purpose of this Paragraph (C2.5.2), the following definitions apply:

(a) *Rated primary current*—

(i) for arc welding machines conforming with the AS 60974 series, the marked rated input current, or the marked corrected primary current where fitted with power factor correction equipment; and

(ii) for all other welding machines, the current obtained by multiplying the rated kilovolt amperes (kVA) by 1000 and dividing by the rated primary voltage using the values given on the nameplate.

(b) *Actual primary current* The current drawn from the supply circuit during each welding operation at the particular heat tap and control setting used.

(c) *Duty cycle* The ratio of the time during which welding current flows to the standard period of 1 min, expressed as a percentage.

Example 1:

A spot welder supplied by a 50 Hz system (3000 cycles/min) making six 15-cycle welds per minute would have a duty cycle of—

$$\frac{6 \times 15 \times 100}{3000} = 3\%$$

Example 2:

A seam welder operating two cycles 'ON' and two cycles 'OFF' would have a duty cycle of 50%.

NOTE: The current-carrying capacity of the supply conductors necessary to limit the voltage drop to a value permissible for the satisfactory performance of welding machines may sometimes be greater than that required to prevent overheating of the conductors.

C2.5.2.2 *Arc welding machines*

The following applies to arc welding machines:

(a) *Individual machine* The maximum demand of an individual arc welding machine is deemed to be 100% of the rated primary current.

(b) *Groups of machines* The maximum demand of two or more arc welding machines is deemed to be as follows:

   (i) *Two largest welding machines* 100% of each rated primary current.

   plus

   (ii) *Next largest welding machine* 85% of the rated primary current.

   plus

   (iii) *Next largest welding machine* 70% of the rated primary current.

   plus

   (iv) *All other welding machines* 60% of the rated primary current.

C2.5.2.3 *Resistance welding machines*

The following applies to resistance welding machines:

(a) *Individual machines* The maximum demand for an individual resistance welding machine is deemed to be as follows:

   (i) *Varying operation* 70% of the rated primary current for seam and automatically fed machines, and 50% of the rated primary current for manually operated, non-automatic machines.

   (ii) *Specific operation* The product of the actual primary current and the multiplier given below for the duty cycle at which the welder will be operated under specific operating conditions for which the actual primary current and duty cycle are known and remain unchanged.

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Duty cycle %:	50	40	30	25	20	15	10	7.5	≤ 5.0
Multiplier:	0.71	0.63	0.55	0.50	0.45	0.39	0.32	0.27	0.22

(b) *Groups of machines* The demand for two or more resistance welding machines is deemed to be the sum of the values obtained in accordance with Item (a) for the largest welding machine supplied, and 60% of the values obtained in accordance with Item (a) for all other welding machines supplied.

C2.5.3 *Domestic cooking appliances*

The maximum demand current for a final subcircuit connected to a fixed or stationary range, oven or hotplate installed in a domestic installation may be less than the full connected load of the equipment.

Table C5 provides assessed maximum demand values that may be applied to a final subcircuit supplying—

(a) an individual appliance using the energy rating of the appliance; or

(b) more than one appliance, e.g. separate oven and hotplates using the total energy rating of the appliances.

TABLE C5

MAXIMUM DEMAND—DOMESTIC COOKING APPLIANCES

Appliance full-load energy rating per phase	Assessed maximum demand
Not greater than 5000 W	16 A
Greater than 5000 W but not greater than 8000 W	20 A
Greater than 8000 W but not greater than 10 000 W	25 A
Greater than 10 000 W but not greater than 13 000 W	32 A
Greater than 13 000 W	40 A

C2.5.4 *Interlocked equipment*

Where more than one item of equipment is connected to the same final subcircuit, but is interlocked so that only a limited number of items can be connected at one time, e.g. duty and stand-by arrangements, the maximum demand may be assessed from the combination of items that presents the highest simultaneous load.

C3 SIMPLIFIED PROTECTIVE DEVICE SELECTION

As specified in Clause 3.4, the current-carrying capacity of cables is required to be determined from the AS/NZS 3008.1 series. These Standards provide a comprehensive set of tables and calculation methods taking into account different cable/conductor types, installation methods and external influences.

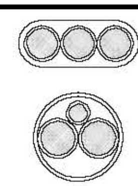
For many typical and simple applications, reference to AS/NZS 3008.1 may not be needed or warranted and an alternative, albeit more conservative, approach may be adopted by limiting the current that can be provided to the circuit by the selection of appropriately rated protective devices.

Tables C6 and C7 provide guidance on the selection of protective devices suitable for use with cables of cross-sectional area from 1 mm^2 to 25 mm^2, for single-phase and three-phase cable applications respectively, under a range of installation conditions.

TABLE C6

SIMPLIFIED PROTECTIVE DEVICE SELECTION FOR CABLES FROM 1 mm^2 TO 25 mm^2 USED IN SINGLE-PHASE APPLICATIONS

Cable type—PVC insulated and sheathed cables, two-core and earth marked V-90



Cable cross-sectional area mm^2	Protective device rating (I_n) A				
	Unenclosed			Enclosed	
	In air	In thermal insulation partially surrounded	In thermal insulation completely surrounded	In air	In ground (see Note 3)
1	16	10	8	13	16
1.5	20	16	10	16	20
2.5	25	20	16	20	32
4	32	25	20	25	40
6	40	32	25	32	50
10	63	50	32	50	63
16	80	63	40	63	80
25	100	80	50	80	100

NOTES TO TABLES C6 AND C7:

1 Protective device ratings (I_n) have been assigned to align with typical current-carrying capacity (I_z) figures for flat and circular cables in AS/NZS 3008.1.1 for Australian conditions. The same ratings can be conservatively applied to New Zealand conditions.

2 Single-circuit installation methods have been provided to keep the tables simple. De-rating factors for groups of cables are not addressed, as it is presumed that circuits will—

(a) be separated from each other; and

(b) operate below maximum current in lower ambient temperature; or

(c) for cables assigned normal ratings of 75°C, any increased temperature effects from grouping will not raise cable temperature above 90°C.

NOTES TO TABLES C6 AND C7 (*continued*):

3 Other cables and installation methods can be sourced from the AS/NZS 3008.1 series, or conservatively compared with the protective device ratings for the following cable installation conditions:

(a) Cables buried direct in the ground may be treated as enclosed in ground.

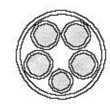
(b) Unenclosed or enclosed cables in air touching a surface may be treated as in air.

(c) Cables lying on top of thermal insulation may be treated as in thermal insulation partially surrounded.

(d) Cables passing through more than 300 mm of thermal insulation may be treated as in thermal insulation completely surrounded.

TABLE C7

SIMPLIFIED PROTECTIVE DEVICE SELECTION FOR CABLES FROM 1 mm^2 TO 25 mm^2 USED IN THREE-PHASE APPLICATIONS

Cable type—PVC insulated and sheathed cables, four-core and earth, marked V-90					
Cable cross-sectional area mm^2	**Protective device rating (I_n) A**				
	Unenclosed			**Enclosed**	
	In air	**In thermal insulation partially surrounded**	**In thermal insulation completely surrounded**	**In air**	**In ground**
1	13	10	6	13	16
1.5	16	13	8	16	20
2.5	20	16	10	20	25
4	32	20	16	25	32
6	40	32	20	32	40
10	50	40	25	40	50
16	63	50	32	63	63
25	80	63	40	80	80

NOTE: See Notes to Table C6.

C4 SIMPLIFIED VOLTAGE DROP

C4.1 Background

As indicated in Clause 3.6, the voltage drop in cables may be determined from the AS/NZS 3008.1 series. The Standard provides a comprehensive set of tables and calculation methods taking into account different cable/conductor types, operating temperatures and installation methods.

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The basic formula used in the AS/NZS 3008.1 series is—

$$V_d = (L \times I \times V_c)/1000 \quad \text{. . . C1}$$

where

V_d = actual voltage drop on circuit; in volts, V

L = route length of circuit; in metres, m

I = circuit current (usually maximum demand); in amperes, A

V_c = cable voltage drop per ampere-metre length of the circuit; in millivolts per ampere-metre, mV/Am

Values of V_c are tabulated in the AS/NZS 3008.1 series.

This formula can be made simpler to apply by expressing the resulting voltage drop in percentage terms, as this allows for the percentage voltage on each section, i.e. consumer mains, submains and final subcircuits, to be added together, regardless of whether it is single-phase or three-phase. When the voltage drop in a circuit is expressed as a percentage of the circuit operating voltage, the formula becomes—

$$\%V_d = (100/V_o) \times (L \times I \times V_c)/1000 \quad \text{. . . C2}$$

$$= (L \times I \times V_c)/(10 \times V_o)$$

where

$\%V_d$ = actual voltage drop in circuit as a fraction of circuit-operating voltage; in percentage, %

V_o = circuit-operating voltage; in volts, V

The above formula can be also be rewritten in favour of the usual factors that are known about a particular circuit. Its intended length and circuit-current as follows:

$$(L \times I)/\%V_d = (10 \times V_o)/V_c$$

the units of which may be expressed as Am per $\%V_d$.

Table C8 provides a simple tabulation of the terms $(10 \times V_o)/V_c$ developed using values for V_c from the AS/NZS 3008.1.1 series for common PVC/PVC cable types operating at 75°C, and 230 V and 400 V for single-phase and three-phase circuits respectively.

Where the conditions of route length and circuit current are known, Table C7 may be used to determine—

(a) the required cable size for a specified percentage voltage drop in the circuit; and

(b) the percentage voltage drop that a particular cable will provide.

Examples are provided to illustrate these operations.

TABLE C8

VOLTAGE DROP—SIMPLIFIED METHOD

Cable conductor size	Single-phase (230 V) circuit	Three-phase (400 V) circuit
	Am per %V_d	Am per %V_d
1 mm^2	45	90
1.5 mm^2	70	140
2.5 mm^2	128	256
4 mm^2	205	412
6 mm^2	306	615
10 mm^2	515	1034
16 mm^2	818	1643
25 mm^2	1289	2588
35 mm^2	1773	3560
50 mm^2	2377	4772
70 mm^2	3342	6712
95 mm^2	4445	8927

C4.2 Examples

To find the minimum cable size for given circuit conditions:

What size cable would be necessary to carry 50 A over a route length of 75 m with a maximum voltage drop of 2.5%?

STEP	PROCESS	CALCULATION
1	Determine required Am by multiplying current by route length	$50 \times 75 = 3750$ Am
2	Determine required capacity for permitted voltage drop, Am per %V_d	3750/2.5 = 1500 Am per %V_d
3	Look up Am per %V_d value in Table C7 which is not less than required value	Single-phase circuit: **35 mm^2** (1773 Am per %V_d) Three-phase circuit: **16 mm^2** (1643 Am per %V_d)

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To find voltage drop in a given circuit:

What is the voltage drop (%) for a single-phase circuit carrying 30 A over a route length of 25 m?

STEP	PROCESS	CALCULATION
1	Determine required Am by multiplying current by route length	30 × 25 = 750 Am
2	Look up Am per $\%V_d$ values in Table C7 for possible cable sizes	4 mm^2 = 205 Am per $\%V_d$ 6 mm^2 = 306 Am per $\%V_d$ 10 mm^2 = 515 Am per $\%V_d$
3	Divide required Am by Am per $\%V_d$ values for possible cable sizes	4 mm^2 = 750/205 = **3.65%** 6 mm^2 = 750/306 = **2.45%** 10 mm^2 = 750/515 = **1.46%**

C5 NUMBER OF POINTS CONNECTED TO CIRCUITS

C5.1 Number of circuits

Each item of equipment that has a current rating in excess of 20 A per phase should be connected to a separate and distinct circuit.

Where more than one item of equipment is to be connected to a circuit, consideration needs to be given to—

(a) the number, distribution and type of equipment (lighting, socket-outlets or appliances, etc.), i.e. points, that are to be supplied in combination;

(b) the operating characteristics of the different items of equipment, including seasonal or daily variations;

(c) the circuit current under expected operating conditions and the coordination with cable and protective device ratings to minimize the risk of an overload fault; and

(d) the effects of an overload fault on the circuit, including loss of supply to equipment that performs a special function, e.g. security, emergency, medical or critical information and telecommunications purposes.

Paragraph C5.2, together with Table C9, provides a method that has been used over several editions of this Standard and, provided that care is taken to assess the presence of unusual equipment loads, is considered appropriate for many typical applications.

C5.2 Final subcircuits

Guidance on the determination of the number of socket-outlets, lighting and appliances, i.e. points that may be connected to a final subcircuit, is given in Table C9.

TABLE C9

GUIDANCE ON THE LOADING OF POINTS PER FINAL SUBCIRCUIT

Cable cross-sectional area(1)	Rating of circuit-breaker(1)	Contribution of each point (A) (sum not to exceed rating of circuit-breaker)						Maximum connected load for a range(4, 5)
		Lighting points(6)	10 A single-phase or multiphase socket-outlets(3, 7, 8, 9)		15 A single-phase or multi-phase socket-outlets(8, 9)	20 A single-phase or multi-phase socket-outlets(8, 9)	Permanently connected fixed or stationary appliances(6, 10) or water heaters	
			Non-domestic installations without permanent airconditioning	All domestic installations and non-domestic installations with permanent airconditioning				
mm²	A							W
1	6	0.5	NP	NP	NP	NP	Connected load	NP
1	8	0.5	NP	NP	NP	NP		NP
1	10	0.5	NP	NP	NP	NP		NP
1	13	0.5	NP	NP	NP	NP		NP
1	16	0.5	NP	NP	NP	NP		NP
1.5	8	0.5	NP	NP	NP	NP		NP
1.5	10	0.5	NP	NP	NP	NP		NP
1.5	13	0.5	NP	NP	NP	NP		NP
1.5	16	0.5	NP	NP	NP	NP		5000
1.5	20	0.5	NP	NP	NP	NP		5000
2.5	10	0.5	NP	NP	NP	NP		NP
2.5	13	0.5	2	1	NP	NP		NP
2.5	16	0.5	2	1	15	NP		5000
2.5	20	0.5	2	1	12	20		8000
2.5	25	0.5	2	1	10	18		8000

(*continued*)

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TABLE C9 *(continued)*

Cable cross-sectional area[(1)]	Rating of circuit-breaker[(1)]	Contribution of each point (A) (sum not to exceed rating of circuit-breaker)						Maximum connected load for a range[(4, 5)]
		Lighting points[(6)]	10 A single-phase or multiphase socket-outlets[(3, 7, 8, 9)]		15 A single-phase or multi-phase socket-outlets[(8, 9)]	20 A single-phase or multi-phase socket-outlets[(8, 9)]	Permanently connected fixed or stationary appliances[(6, 10)] or water heaters	
			Non-domestic installations without permanent airconditioning	All domestic installations and non-domestic installations with permanent airconditioning				
mm^2	A							W
2.5	32	0.5	2	1	8	16		10 000
4	16	0.5	2	1	15	NP		5000
4	20	0.5	2	1	12	20		8000
4	25	0.5	2	1	10	18		10 000
4	32	0.5	2	1	8	16		10 000
6[(2)]	20	0.5	2	1	12	20		10 000
6[(2)]	25	0.5	2	1	10	18		10 000
6[(2)]	32	0.5	2	1	8	16		13 000
10[(2)]	32	0.5	2	1	8	16		13 000
10[(2)]	40	0.5	2	1	8	16		>13 000

NP = denotes socket-outlets not permitted on these circuits

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NOTES TO TABLE C9:

1 Cable cross-sectional areas and protective device ratings relate directly to specified installation methods given in Tables C6 and C7, e.g. a 2.5 mm² cross-sectional area cable used in conjunction with a 20 A protective device is recommended for use in Table C5 for a single-phase circuit partially surrounded in thermal insulation or from Table C6 for a three-phase circuit unenclosed in air.

2 Figures for 6 mm² and 10 mm² conductors are given primarily for dedicated circuits supplying permanently connected fixed or stationary appliances, water heaters and ranges. While this Standard does not prescribe the installation of socket-outlets and lighting points on these circuits, the physical limitations of the terminals of these devices may make their connection impractical.

3 For the purposes of determining the number of points, a multiple combination of socket-outlets is regarded as the same number of points as the number of integral socket-outlets in the combination.

4 A hotplate and oven are considered to be one cooking appliance if mounted within one room.

5 Maximum demand is limited by the circuit-breaker on the final subcircuit, which allows for diversity in operation of the range elements and hotplates.

6 *Lighting points* A luminaire is deemed to comprise one or more lighting points, according to the number of points at which it is connected by flexible cords to the installation wiring, or according to the number of sections in which it is switched or controlled. Connections of festoon lighting and decorative lighting are not regarded as lighting points. See Table C1 for track systems and ELV lighting.

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.

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.

7 Applies to circuits with 10 A socket-outlets connected where there are two or more circuits in an electrical installation.

8 *Restricted connections* Table C9 precludes the connection of any socket-outlets on conductors having a cross-sectional area less than 2.5 mm², except where they are used for the connection of a lighting point, or appliance rated at not more than 150 W and installed more than 2.3 m above a floor [see Note 6 above].

9 The values are intended to be utilized when the final subcircuit is provided for general use. Where it is known that socket-outlets may be used for specific items of electrical equipment, such as dishwashers, room heaters or clothes dryers, the actual load of the equipment should be substituted.

10 Fixed and stationary appliances may be connected permanently or through socket-outlets.

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C6 GUIDE TO MAXIMUM NUMBER OF CABLES INSTALLED IN CONDUITS

C6.1 General

This information is intended to be used as a guide for determining the number of cables and circuits that may be installed, without damage, in conduits and other forms of wiring enclosure.

C6.2 Basis of calculations

The number of cables that can be installed in a circular conduit is determined from the ratios of the cross-sectional areas of the enclosure and the cable as follows:

$$\text{Number of cables} = \frac{\text{internal cross-sectional area of enclosure}}{\text{cross-sectional area of cable}} \times \text{space factor}$$

where the space factor recognizes the reduction of space available from the circular geometry of the cables and enclosures.

(a) For one cable in enclosure .... 0.5.

(b) For two cables in enclosure .... 0.33.

(c) For three or more cables in enclosure .... 0.4.

Tables C10 to C12 demonstrate the application of the equation for combinations of common conduit and cable types.

C6.3 Application notes

Cable types and sizes used in Tables C10 to C12 are based on manufacturer’s catalogue nominal sizes for cables conforming to AS/NZS 5000.1 and AS/NZS 5000.2. For common building cable types, such as two-core and earth flat PVC/PVC V90 cables, the number of cables has increased because of the smaller cable dimensions of the 450/750 V rated cables.

The conduit sizes and types used in Tables C10 to C12 are based on nominal bore dimensions determined from AS/NZS 2053.2 (rigid UPVC), AS/NZS 2053.5 (corrugated) and AS/NZS 2053.6 (profile wall smooth bore).

The calculation method may also be applied to other combinations of circular and non-circular enclosures, and cables of different types and sizes within the same enclosure, provided that the shape of the cables and enclosures are compatible.

The number of cables determined by the calculation assumes that the enclosure is relatively short in length, is clear of obstructions and distortions, and that the quantity and arrangement of impediments, such as bends, is minimized. Where this is not the case, the number of cables should be reduced and measures taken to ensure that the maximum cable pulling tension and bending radius are not exceeded.

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The calculation for the number of cables does not consider the effects of grouping cables on current-carrying capacity, temperature rise and voltage drop. AS/NZS 3008 provides de-rating factors for grouping that need to be considered in determining the suitability of circuits.

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TABLE C10

GUIDE TO THE MAXIMUM NUMBER OF SINGLE-CORE SHEATHED CABLES INSTALLED IN CONDUIT

Cable size	Heavy duty rigid UPVC conduit												Corflo conduit				Medium duty corrugated				Medium duty rigid UPVC conduit					
	20	25	32	40	50	63	80 (NZ)	80 (AUS)	100 (NZ)	100 (AUS)	125	150	100 (NZ)	100 (AUS)	125	150	20	25	32	40	16	20	25	32	40	50
PVC/PVC V90																										
1	5	9	16	26	43	71	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	4	7	14	23	3	6	10	17	28	45
1.5	4	7	13	21	36	59	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	3	6	11	19	3	5	8	14	23	38
2.5	3	5	10	16	27	44	79	92	>100	>100	>100	>100	>100	>100	>100	>100	2	4	8	14	1	3	6	11	17	28
4	1	3	7	11	19	31	56	64	99	>100	>100	>100	99	>100	>100	>100	1	3	6	10	1	2	4	7	12	20
6	1	3	6	9	16	26	48	55	85	92	>100	>100	85	89	>100	>100	1	2	5	8	1	1	3	6	10	17
10	1	1	4	6	11	18	32	38	58	63	95	>100	58	60	90	>100	1	1	3	5	1	1	2	4	7	11
16	1	1	3	5	8	13	24	28	43	46	70	92	43	45	67	88	1	1	2	4	0	1	1	3	5	8
XLPE/PVC																										
25	0	1	1	3	5	9	16	19	29	31	48	62	29	30	45	60										
35	0	1	1	2	4	7	13	15	24	26	39	52	24	25	38	50										
50	0	1	1	1	3	6	10	12	19	21	31	41	19	20	30	40										
70	0	0	1	1	2	4	8	9	15	16	24	31	15	15	23	30										
95	0	0	1	1	1	3	6	7	11	12	18	24	11	12	17	23										
120	0	0	0	1	1	2	5	6	9	10	15	20	9	10	14	19										
150	0	0	0	1	1	2	4	5	7	8	12	16	7	8	12	16										
185	0	0	0	0	1	1	3	4	6	6	10	13	6	6	10	13										
240	0	0	0	0	1	1	2	3	5	5	8	10	5	5	7	10										
300	0	0	0	0	1	1	1	2	4	4	6	8	4	4	6	8										
400	0	0	0	0	0	1	1	1	3	3	5	7	3	3	5	6										
500	0	0	0	0	0	1	1	1	3	3	4	6	3	3	4	6										
630	0	0	0	0	0	0	1	1	1	2	3	4	1	1	3	4										

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TABLE C11

GUIDE TO THE MAXIMUM NUMBER OF TWO-CORE AND EARTH CABLES INSTALLED IN CONDUIT

Cable size	Heavy duty rigid UPVC conduit												Corflo conduit				Medium duty corrugated				Medium duty rigid UPVC conduit					
	20	25	32	40	50	63	80 (NZ)	80 (AUS)	100 (NZ)	100 (AUS)	125	150	100 (NZ)	100 (AUS)	125	150	20	25	32	40	16	20	25	32	40	50
PVC/PVC V90																										
1.5	1	1	2	4	7	11	21	24	38	41	62	81	38	40	59	78	1	1	1	3	0	1	1	2	4	7
2.5	0	1	1	3	5	9	16	19	30	32	48	63	30	31	46	61	0	1	1	3	0	1	1	1	3	6
4	0	1	1	2	4	7	13	15	23	25	38	50	23	24	36	48	0	1	1	2	0	0	1	1	2	4
6	0	1	1	2	4	6	12	13	21	23	34	45	21	22	33	43	0	0	1	1	0	0	1	1	2	4
PVC/PVC V75																										
10	0	0	1	1	2	4	7	9	13	15	22	29	13	14	21	28	0	0	1	1	0	0	0	1	1	2
16	0	0	1	1	1	3	6	7	11	11	18	23	11	11	17	22	0	0	0	1	0	0	0	1	1	1
25	0	0	0	1	1	2	4	5	7	8	12	16	7	8	12	16	0	0	0	1	0	0	0	0	1	1
PVC/PVC V90 FLAT																										
1	1	2	5	8	14	23	42	48	75	81	>100	>100	75	78	>100	>100	1	2	4	7	1	1	3	5	9	15
1.5	1	2	5	8	13	22	40	46	71	77	>100	>100	71	74	>100	>100	1	2	4	7	1	1	3	5	9	14
2.5	1	1	3	5	9	15	28	32	50	54	81	>100	50	52	77	>100	1	1	3	5	1	1	1	3	6	10
4	1	1	2	4	6	11	20	23	36	38	58	76	36	37	55	73	0	1	1	3	0	1	1	2	4	7
6	0	1	1	3	5	9	17	19	30	32	49	64	30	31	47	62	0	1	1	3	0	1	1	2	3	6
10	0	1	1	2	4	7	12	14	22	24	36	47	22	23	34	45	0	1	1	1	0	0	1	1	2	4
16	0	0	1	1	2	4	8	9	14	15	23	31	14	15	22	30	0	0	1	1	0	0	0	1	1	2

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TABLE C12

GUIDE TO THE MAXIMUM NUMBER OF FOUR-CORE AND EARTH CABLES INSTALLED IN CONDUIT

Cable size	Heavy duty rigid UPVC conduit												Corflo conduit				Medium duty corrugated				Medium duty rigid UPVC conduit					
	20	25	32	40	50	63	80 (NZ)	80 (AUS)	100 (NZ)	100 (AUS)	125	150	100 (NZ)	100 (AUS)	125	150	20	25	32	40	16	20	25	32	40	50
PVC/PVC V90																										
1.5	0	1	1	3	5	9	16	18	29	31	47	61	29	30	45	59	0	1	1	2	0	1	1	1	3	5
2.5	0	1	1	2	4	6	12	14	21	23	35	46	21	22	33	44	0	0	1	1	0	0	1	1	2	4
4	0	0	1	1	3	5	9	10	16	18	27	35	16	17	26	34	0	0	1	1	0	0	1	1	1	3
6	0	0	1	1	2	4	8	9	14	15	23	31	14	15	22	29	0	0	1	1	0	0	0	1	1	2
PVC/PVC V75																										
10	0	0	0	1	1	2	5	6	9	10	15	20	9	10	14	19					0	0	0	0	1	1
16	0	0	0	1	1	1	4	4	7	8	12	15	7	7	11	15					0	0	0	0	1	1
25	0	0	0	0	1	1	3	3	5	5	8	11	5	5	8	11					0	0	0	0	0	1
35	0	0	0	0	1	1	2	2	4	4	7	9	4	4	6	9										
50	0	0	0	0	0	1	1	1	3	3	5	6	3	3	5	6										
70	0	0	0	0	0	1	1	1	2	2	4	5	2	2	3	5										
95	0	0	0	0	0	0	1	1	1	1	3	4	1	1	2	3										
XLPE/PVC																										
16	0	0	0	1	1	3	5	6	9	10	15	20	9	10	15	19										
25	0	0	0	0	1	1	3	3	6	6	9	12	6	6	9	12										
35	0	0	0	0	1	1	2	3	4	5	7	10	4	5	7	9										
50	0	0	0	0	0	1	1	2	3	3	6	7	3	3	5	7										
70	0	0	0	0	0	1	1	1	2	2	4	5	2	2	4	5										
95	0	0	0	0	0	0	1	1	1	1	3	4	1	1	3	4										
120	0	0	0	0	0	0	1	1	1	1	2	3	1	1	2	3										

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