US 1702 Part 4

Demonstrate knowledge of, and apply electrical legislation, New Zealand Codes of Practice, and Standards

This unit was compiled by Monica Kershaw

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1. Maximum Demand

2.2.2 Maximum demand

The maximum demand in consumers mains, submains and final subcircuits, taking account of the physical distribution and intended usage of electrical equipment in the electrical installation and the manner in which the present requirements might vary, shall be determined using one of the methods set out in Items (a) to (d). If the actual measured maximum demand is found to exceed that obtained by calculation or assessment, the measured value shall be deemed to be the maximum demand.

NOTE: Guidance on the determination of maximum demand is provided for basic electrical installations in Appendix C.

(a) Calculation The maximum demand may be calculated in accordance with the guidance given in Appendix C for the appropriate type of electrical installation and electrical equipment supplied. It is recognized that there may be considerable differences in loading from one electrical installation to another. Alternative methods of calculating the maximum demand may be used taking account of all the relevant information available for any particular electrical installation.

(b) Assessment The maximum demand may be assessed where—

(i) the electrical equipment operates under conditions of fluctuating or intermittent loading, or a definite duty cycle; or
(ii) the electrical installation is large and complex; or
(iii) special types of occupancy exist.

(c) Measurement The maximum demand may be determined by the highest rate of consumption of electricity recorded or sustained over any 15 min period or periods when demand is at its highest by a maximum demand indicator or recorder.

(d) Limitation The maximum demand may be determined by the current rating of a fixed setting circuit-breaker, or by the load setting of an adjustable circuit-breaker.

The maximum demand of consumers mains and submains may be determined by the sum of the current settings of the circuit-breakers protecting the associated final subcircuit/s and any further submain/s.

Question 1

Refer to AS/NZS 3000 and calculate the maximum demand in amps of a 230V domestic installation with the following loads:

Number	Rating	Equipment
30	100W	Lighting points
10	75W	Outdoor lighting – discharge lamps
1	6kW	Electric range
18	10A	Double socket outlets
10	10A	Single socket outlets
1	3KW	Water storage heater
1	6kW	Sauna

Use the grid on the following page to perform the calculations.

Equipment	Load Group	Calculation	Load in amps

Ref: .....

Question 2

A 230V domestic installation is being supplied from a 230V, single-phase supply.
Refer to AS/NZS 3000 and determine the maximum demand in amps of the installation
The installation has the following loads:
All lighting is to be assessed on a connected load basis.

Number	Rating	Equipment
14	100W each	Incandescent lights
4	0.3A each	Fluorescent lights
1	6 metres	Lighting track
1	3kW total	Outside lights
20	10A each	Single socket outlets
1	10A	Socket outlet supplying controls for a gas water heater
2	15A each	Socket outlets
1	8kW total	Electric range
1	6kW input	Air conditioner

Use the table on the following page to do the calculations

Equipment	Load Group	Calculation	Load in amps

Ref: .....

Equipment	Load Group	Calculation	Load (Amps)
25 - lighting points			
10 metres of lighting track			
10 – 150W outside lights			
18 - double socket outlets (10 A)			
10 - single socket outlets (10 A)			
1 - 3 kW controlled water heater			
1 - electric range (6 kW)			
2 – 15A space heaters			
1 – 4 kW air conditioner unit			
Total Maximum Demand			

Ref: .....

demand in amperes of ONE domestic electrical installation.

Each electrical installation has the following loads:

32	Lighting points	1	Electric oven – 2.5kW

4	Double socket outlets (10A)	1	Storage water heater – 2kW
10	Single socket outlets (10A)	1	Air-conditioning unit – 4kW Input

Equipment	Load Group	Calculation	Load (Amps)
32 - lighting points			
4 – 10A double socket outlets			
10 – 10A single socket outlets			
1 – 2.5 kW electric oven			
1 – 2 kW storage water heater			
1 – 4 kW air conditioner unit			
Total Maximum Demand			

Ref: .....

Question 5

Refer to AS/NZS 3000 and determine the maximum demand in amps of a 230 volt domestic installation with the following loads:

37	lighting points	1	12 kW electric range

6	Metres of lighting track	1	Gas water heater with controllers supplied from a 10A socket outlet
	3kW outside lighting	15	10A double socket outlets
1	6kW air conditioner	10	10A single socket outlets

Note: All lighting is to be calculated on a points basis

Load Group	Calculation	Load (A)
Group		
Group		
Group		
Group		
Group		
Total maximum demand		

Ref: .....

Question 6

You are wiring a new three-phase, 400 V, factory and need to determine the load of the highest loaded phase of the installation so the correct size of the mains can be found. Assume all motors, lighting, and loads in the socket outlets to have a unity power factor.

The loads are to be balanced across the three phases wherever possible. Refer to AS/NZS 3000 and calculate the load in amps on each phase (red, white and blue) to determine the highest loaded phase of the installation.
Use the table on the following page for your calculations.

Single-phase

Number	Equipment
12	38W Fluorescent lights
30	75W Fluorescent lights
18	10A socket outlets
9	15A Socket outlets
1	5kW water heater

Three-phase

Number	Equipment
2	9kW motors (15.8A per phase nameplate rating)
2	5kW chiller motors (7.25A per phase nameplate rating)

(a) Calculations

Load Group	Calculation	Load on each phase (amps)		
		R	W	B
Group				
Group				
Group				
Group				
				-
Total				

(b) Load on highest loaded phase =

Ref: .....

2. Cable Selection

3.1.2 Selection and installation

Wiring systems shall be selected and installed to perform the following functions associated with the safe design and construction and proper operation of the electrical installation:

(a) Protect against physical contact with live parts by durable insulation materials or by placing live parts out of reach.

(b) Satisfy current-carrying capacity, voltage drop and other minimum size requirements for conductors.

(c) Provide reliability and electrical continuity of connections, joints and terminations.

(d) Provide adequate strength of supports, suspensions and fixings.

(e) Suit intended use, including applications requiring a particular type of wiring system, e.g. fire-resistance, explosion protection, safety services.

(f) Protect against mechanical damage, environmental and other external influences by enclosure or other means.

AS/NZS 3008.1.2 TABLE SET 1

The following are extracts from AS/NZS 3008.1.2.

TABLE 10

CURRENT-CARRYING CAPACITIES

CABLE TYPE: **TWO-CORE SHEATHED**
Cable with or without earth core, armoured or unarmoured, including neutral screened cables

INSULATION TYPE **THERMOSPLASTIC**

MAXIMUN CONDUCTOR TEMPERATURE **75°C**

REFERENCE AMBIENT TEMPERATURE **30°c IN AIR, 15°C IN GROUND**

1	2	3	4	5	6	7	8	9	10	11	12	13
Conductor size	Current carrying capacity A											
	Unenclosed									Enclosed		
	Spaced			Touching			Exposed to sun			Wiring enclosure in air		
	Cu		Al	Cu		Al	Cu		Al	Cu		Al
mm²	Solid/stranded	Flexible		Solid/stranded	Flexible		Solid/stranded	Flexible		Solid/stranded	Flexible	
1	17	18	-	16	17	-	13	14	-	15	15	-
1.5	22	23	-	21	21	-	16	16	-	18	19	-
2.5	31	30	-	30	29	-	23	22	-	26	26	-
4	42	40	-	39	38	-	31	30	-	34	33	-
6	52	51	-	50	48	-	39	36	-	44	43	-
10	73	72	-	68	67	-	52	51	-	59	58	-
16	97	95	75	91	89	71	68	67	54	78	78	59
25	129	125	100	122	119	95	90	88	71	103	99	80
35	158	156	123	149	146	115	111	107	86	128	124	99
50	194	195	150	181	184	141	132	133	103	152	153	117
70	245	245	190	229	230	178	165	165	128	194	193	150
95	302	293	234	283	275	219	200	194	155	233	226	180
120	350	347	272	328	325	255	230	227	179	275	269	213
150	400	397	310	374	372	291	259	257	202	309	304	239
185	459	450	358	430	422	335	294	287	229	357	348	278
240	544	536	425	508	500	398	342	335	268	415	420	325
300	624	612	489	583	572	457	386	377	303	483	473	380
400	719	725	570	671	676	532	438	438	348	549	570	437
500	816	830	656	762	773	611	489	491	393	640	643	514

TABLE 10 CONTINUED

CURRENT-CARRYING CAPACITIES

CABLE TYPE: **TWO-CORE SHEATHED**
Cable with or without earth core, armoured or unarmoured, including neutral screened cables

INSULATION TYPE **THERMOSPLASTIC**

MAXIMUN CONDUCTOR TEMPERATURE **75^{0}C**

REFERENCE AMBIENT TEMPERATURE **30^{0}c IN AIR, 15^{0}C IN GROUND**

14	15	16	17	18	19	20	21	22	23	24	25	26	27
Conductor size	Current carrying capacity A												
	Thermal insulation								Buried direct		Underground wiring enclosure		
	Partially surrounded by thermal insulation, unenclosed		Partially surrounded by thermal insulation, in a wiring enclosure		Completely surrounded by thermal insulation, unenclosed		Completely surrounded by thermal insulation, in a wiring enclosure						
mm^2	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu		Al
											Solid/stranded	Flexible	
1	13	-	11	-	8	-	7	-	19	-	19	20	-
1.5	61	-	15	-	10	-	9	-	23	-	23	24	-
2.5	23	-	22	-	15	-	14	-	33	-	33	32	-
4	31	-	27	-	19	-	17	-	43	-	43	42	-
6	40	-	35	-	25	-	23	-	55	-	55	53	-
10	55	-	48	-	34	-	30	-	73	-	73	72	-
16	73	56	62	48	46	35	39	30	125	97	95	94	73
25	97	75	82	64	60	47	51	40	162	125	123	119	96
35	120	92	103	80	74	58	64	49	196	152	150	146	117
50	145	113	122	95	-	-	-	-	232	179	178	179	139
70	184	143	155	120	-	-	-	-	285	221	222	222	173
95	226	176	186	145	-	-	-	-	342	265	267	260	208
120	262	204	219	171	-	-	-	-	391	304	310	305	242
150	300	233	247	192	-	-	-	-	438	340	349	344	271
185	344	268	285	222	-	-	-	-	494	385	399	388	311
240	407	318	332	260	-	-	-	-	572	447	463	461	362
300	466	366	388	303	-	-	-	-	645	506	531	519	417
400	537	425	440	349	-	-	-	-	729	579	603	616	477
500	609	489	512	410	-	-	-	-	815	655	691	692	554

TABLE 13

CURRENT-CARRYING CAPACITIES

CABLE TYPE: **THREE-CORE AND FOUR-CORE**
Cable with or without earth core, armoured or unarmoured, including neutral screened cables

INSULATION TYPE **THERMOSPLASTIC**

MAXIMUN CONDUCTOR TEMPERATURE **75^{0}C**

REFERENCE AMBIENT TEMPERATURE **30^{0}c IN AIR, 15^{0}C IN GROUND**

1	2	3	4	5	6	7	8	9	10	11	12	13
Conductor size	Current carrying capacity A											
	Unenclosed									Enclosed		
	Spaced			Touching			Exposed to sun			Wiring enclosure in air		
	Cu		Al	Cu		Al	Cu		Al	Cu		Al
mm^2	Solid/stranded	Flexible		Solid/stranded	Flexible		Solid/stranded	Flexible		Solid/stranded	Flexible	
1	15	15	-	14	15	-	10	11	-	13	13	-
1.5	18	19	-	17	18	-	14	14	-	16	16	-
2.5	26	25	-	25	24	-	19	18	-	23	22	-
4	35	34	-	33	32	-	26	25	-	29	27	-
6	46	43	-	42	41	-	33	32	-	38	36	-
10	62	62	-	58	58	-	44	43	-	50	49	-
16	82	81	64	78	76	60	58	57	46	66	65	51
25	111	107	86	104	101	81	76	74	59	87	83	67
35	137	133	106	128	125	99	93	91	73	107	105	83
50	166	169	129	156	157	121	113	114	88	128	128	99
70	211	211	163	196	197	153	140	140	109	162	162	127
95	260	253	202	243	236	188	171	165	132	202	196	156
120	302	299	235	282	278	219	196	193	153	230	227	179
150	345	343	268	321	319	250	221	219	172	260	261	202
185	397	390	310	369	363	288	251	245	196	300	293	235
240	470	464	368	437	431	343	292	286	228	360	352	283
300	538	529	424	499	490	393	328	321	259	-	-	-
400	620	626	495	575	579	458	372	372	296	-	-	-
500	702	715	568	651	661	526	414	416	335	-	-	-

TABLE 13 CONTINUED

CURRENT-CARRYING CAPACITIES

CABLE TYPE: **THREE-CORE AND FOUR-CORE**
Cable with or without earth core, armoured or unarmoured, including neutral screened cables

INSULATION TYPE **THERMOSPLASTIC**

MAXIMUN CONDUCTOR TEMPERATURE **75^{0}C**

REFERENCE AMBIENT TEMPERATURE **30^{0}c IN AIR, 15^{0}C IN GROUND**

14	15	16	17	18	19	20	21	22	23	24	25	26	27
Conductor size	Current carrying capacity A												
	Thermal insulation								Buried direct		Underground wiring enclosure		
	Partially surrounded by thermal insulation, unenclosed		Partially surrounded by thermal insulation, in a wiring enclosure		Completely surrounded by thermal insulation, unenclosed		Completely surrounded by thermal insulation, in a wiring enclosure						
mm^2	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu		Al
											Solid/stranded	Flexible	
1	10	-	10	-	7	-	6	-	15	-	15	17	-
1.5	14	-	13	-	9	-	8	-	20	-	20	20	-
2.5	18	-	18	-	13-	-	11	-	28	-	28	26	-
4	26	-	23	-	17	-	15	-	36	-	36	35	-
6	34	-	30	-	22	-	18	-	46	-	46	44	-
10	47	-	40	-	29	-	25	-	61	-	61	59	-
16	62	48	54	41	39	30	33	26	106	83	80	78	62
25	83	65	68	54	52	40	43	33	138	107	103	100	80
35	103	79	86	66	64	49	54	41	165	129	125	123	98
50	124	97	101	79	-	-	-	-	196	152	150	151	116
70	157	122	130	100	-	-	-	-	241	187	187	186	145
95	194	150	162	125	-	-	-	-	289	224	229	221	177
120	226	176	185	144	-	-	-	-	330	256	261	255	202
150	258	200	207	162	-	-	-	-	370	287	293	292	228
185	295	231	241	188	-	-	-	-	417	326	334	326	261
240	350	274	288	226	-	-	-	-	482	378	395	386	309
300	-	-	-	-	-	-	-	-	542	427	444	433	350
400	-	-	-	-	-	-	-	-	613	488	515	514	411
500	-	-	-	-	-	-	-	-	682	551	574	575	464

Table 27(1)

VARIANCE: **AIR AND CONCRETE SLAB AMBIENT TEMPERATURES**

INSTALLATION CONDITIONS **CABLES IN AIR OR HEATED CONCRETE SLAB**

1	2	3	4	5	6	7	8	9	10	11
Conductor temperature °C	**Rating Factor**									
	Air and concrete slab ambient temperature									
	15	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
150	1.07	1.05	1.03	1.00	0.98	0.96	0.94	0.91	0.89	0.87
110	1.08	1.06	1.03	1.00	0.97	0.93	0.90	0.87	0.83	0.79
90	1.15	1.09	1.05	1.00	0.95	0.91	0.85	0.80	0.74	0.66
80	1.17	1.12	1.06	1.00	0.95	0.89	0.82	0.75	0.68	0.59
75	1.18	1.12	1.06	1.00	0.94	0.88	0.80	0.72	0.63	0.53

Table 27(2)

VARIANCE: **SOIL AMBIENT TEMPERATURES**

INSTALLATION CONDITIONS **CABLES BURIED DIRECT IN GROUND OR IN UNDERGROUND WIRING ENCLOSURES**

1	2	3	4	5	6	7	8
Conductor temperature °C	**Rating Factor**						
	Soil ambient temperature						
	10	**15**	**20**	**25**	**30**	**35**	**40**
110	1.02	1.00	0.97	0.94	0.92	0.89	0.86
90	1.04	1.00	0.96	0.93	0.91	0.87	0.83
80	1.04	1.00	0.95	0.92	0.88	0.83	0.78
75	1.04	1.00	0.95	0.91	0.86	0.81	0.75

Table 42

THREE-PHASE VOLTAGE DROP (V_c) at 50 Hz

CABLE TYPE: MULTICORE WITH CIRCULAR COPPER CONDUCTORS

Conductor size mm²	Three-phase voltage drop (V_c) at 50 Hz, mV/A.m									
	Conductor temperature, °C									
	45		60		75		90		110	
	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.
1	40.3	-	42.5	-	44.7	-	46.8	-	49.7	-
1.5	25.9	-	27.3	-	28.6	-	30.0	-	31.9	-
2.5	14.1	-	14.9	-	15.6	-	16.4	-	17.4	-
4	8.77	-	9.24	-	9.71	-	10.2	-	10.8	-
6	5.86	-	6.18	-	6.49	-	6.80	-	7.22	-
10	3.49	-	3.67	-	3.86	-	4.05	-	4.29	-
16	2.19	-	2.31	-	2.43	-	2.55	-	2.70	-
25	1.39	-	1.47	-	1.54	-	1.61	-	1.71	-
35	1.01	-	1.06	-	1.11	-	1.17	-	1.24	-
50	0.751	-	0.790	-	0.829	-	0.868	-	0.920	-
70	0.530	-	0.556	-	0.583	-	0.609	-	0.645	-
95	0.394	-	0.413	-	0.431	-	0.450	-	0.475	-
120	0.323	-	0.337	-	0.351	-	0.366	-	0.385	-
150	0.274	-	0.285	-	0.296	-	0.307	-	0.322	-
185	0.234	-	0.242	-	0.251	-	0.259	-	0.271	-
240	0.198	0.198	0.204	0.204	0.210	0.210	0.216	0.216	0.224	-
300	0.178	0.175	0.182	0.180	0.186	0.185	0.190	0.189	0.196	0.196
400	0.162	0.157	0.165	0.160	0.168	0.164	0.171	0.167	0.175	0.172
500	0.152	0.143	0.154	0.146	0.156	0.148	0.158	0.151	0.160	0.155

Note: To convert to single-phase values multiply the three-phase value by 1.155

Table 45

THREE-PHASE VOLTAGE DROP (V_c) at 50 Hz

CABLE TYPE: MULTICORE WITH CIRCULAR ALUMINIUM CONDUCTORS

Conductor size mm²	Three-phase voltage drop (V_c) at 50 Hz, mV/A.m									
	Conductor temperature, °C									
	45		60		75		90		110	
	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.
16	3.64	-	3.84	-	4.04	-	4.11	-	4.24	-
25	2.29	-	2.42	-	2.54	-	2.59	-	2.67	-
35	1.66	-	1.75	-	1.84	-	1.87	-	1.93	-
50	1.23	-	1.30	-	1.36	-	1.39	-	1.43	-
70	0.856	-	0.902	-	0.948	-	0.966	-	0.993	-
95	0.626	-	0.659	-	0.691	-	0.706	-	0.723	-
120	0.501	-	0.527	-	0.552	-	0.565	-	0.577	-
150	0.416	-	0.436	-	0.457	-	0.468	-	0.476	-
185	0.341	-	0.357	-	0.373	-	-	-	0.388	-
240	0.274	-	0.285	-	0.297	-	-	-	0.307	-
300	0.233	-	0.242	-	0.251	-	-	-	0.258	-
400	0.200	0.200	0.206	0.206	0.212	-	-	-	0.216	-
500	0.178	0.176	0.182	0.181	0.186	0.185	-	-	0.189	0.189

Note: To convert to single-phase values multiply the three-phase value by 1.155

Question 1

Introduction

You have been asked to install a 4-core neutral screened copper cable from a three-phase 400V, three-phase distribution panel to a three-phase, 400V service centre building in a ski-field. The installation requirements are:

- The cable route length is 45 m.
- The service centre building load is 68 kW.
- The allowance for load increase is 10%
- The cable will be buried direct.
- The ambient soil temperature is 10°C.
- The voltage drop between distribution panel and the service centre switchboard must not exceed 2.5%.
- The conductor temperature is assumed to be 75°C

Use the information in the introduction to this question and information from **AS/NZS 3008.1.2 Table Set 1** to answer the following.

(a) Calculate the minimum size cable that will meet the loading requirements.

(b) Calculate the minimum size cable that will meet the voltage drop requirements.

(c) State the minimum size 4-core neutral screened copper cable that will meet the load and voltage drop requirements.

Question 2

Introduction
A 400V, three-phase low rise development contains 12, 230v domestic electrical installations. The development has 4 units per phase and each unit draws the same current. Calculate the size of the cable required based on the following information
and the information contained in **AS/NZS 3008.1.2 Table Set 1:**

- The rating of ONE unit is 55.04A
- There are 4 units per phase
- The cable will be buried direct.
- The load is based on the calculation in Maximum Demand Question 4
- The ambient soil temperature is 20° C
- The conductor temperature to be 75° C

Note: Voltage drop is not an issue as it is a short length of cable run.

Question 3

Introduction
You have been requested to install a 400V, three-phase stranded copper mains cable to a commercial complex. The best solution that meets the technical requirements must be provided. The stated conditions are:

The cable route length is 70 metres between the point of supply and the main switchboard
40 metres of the cable will be buried direct, the balance will be installed through a building (touching)
The load is 85 amps per phase
The voltage at the switchboard is 400V
The maximum permitted voltage drop is 1.5%
An allowance of 20% for load growth
The ambient soil temperature is 20° C
The ambient air temperature is 35° C
The maximum conductor temperature is 75°C

(a) Use the information in the introduction and information from **AS/NZS 3008.1.2 Table Set 1** and determine by calculation, the minimum size cable that will satisfy the load requirements.

(b) Use the information in the introduction and information from the tables and determine by calculation, the **minimum** size cable that will satisfy the **voltage drop** requirements.

(c) State the minimum size cable that meets both the load and voltage drop requirements.

Question 4

Introduction
A three-phase, 400V, copper, mains cable is being installed to a large new farm complex electrical installation comprising 3 large houses, a large milking shed and associated out-buildings. The customer is to be provided with the best solution that meets the technical requirements.

(a) Calculate and state the minimum size cable that will satisfy the **load requirements** of the installation.
Use the following information and information from **AS/NZS 3008.1.2 Table Set 1** for the calculations.

- The route length between the point of supply and the main switchboard is 60 metres
- The cable will be buried direct
- The load is 60kW balanced over the three phases
- The maximum permitted voltage drop is 1.5%
- An allowance of 20% for load growth
- The ambient **soil** temperature is 10°C
- The conductor temperature to be 75° C

(b) Calculate and state the minimum size cable that will satisfy the **voltage drop** requirements of the installation

(c) State the minimum size cable that meets **both** the load and voltage drop requirements

Question 5

Introduction

A 230V final subcircuit originating at a factory switchboard supplies two socket outlets.

- 30 metres of 4mm2 twin and earth TPS cable from the switchboard supplies the first socket outlet.
- 10 metres of 2.5mm2 twin and earth TPS cable from the first socket outlet supplies the second socket outlet.
- Each socket outlet supplies a 1 kW load.
- The TPS cable is clipped touching.
- The mV/A.m for the 4mm2 twin and earth TPS cable is 11.2151
- The mV/A.m for the 2.5mm2 twin and earth TPS cable is 18.018
- The maximum voltage drop permitted is 2.5%.

(a) Calculate maximum current in **each section** of the final sub-circuit

(b) Determine by calculation whether the maximum voltage drop of the final sub-circuit meets the voltage drop requirements.

AS/NZS 3008.1.2 TABLE SET 2

Table 12

Current Carrying Capacities of Three-Core And Four-Core O.6/1 kV Insulated and Sheathed (including Neutral Screened) Cables with or without Earth Conductor, Armoured or Non-Armoured Cables

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Current carrying capacity A															
	Unenclosed				Enclosed								Buried Direct		Underground non-metallic wiring enclosure	
Conductor size	Spaced		Touching		Non-metallic wiring enclosures in air – round cable		Non-metallic wiring enclosures in air – flat cable		In non-metallic wiring enclosures or unenclosed partially surrounded by thermal insulation		Completely surrounded by thermal insulation					
mm^2	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al
1	15	--	14	--	11	9	14	10	11	8	7	-	21	-	17	-
1.5	18	-	17	-	15	11	17	13	14	11	9	-	26	-	21	-
2.5	26	-	25	-	21	16	23	17	19	15	13	-	37	-	29	-
4	35	-	33	-	27	21	30	23	25	19	17	-	48	-	37	-
6	46	-	42	-	35	27	39	30	33	25	22	-	61	-	47	-
10	52	-	58	-	48	38	52	40	44	34	29	-	81	-	63	-
16	82	64	78	60	64	49	68	52	59	46	39	30	106	83	81	64
25	111	86	104	81	90	68	95	72	82	64	52	40	138	107	106	83
35	137	106	125	99	105	80	105	80	96	74	64	49	165	127	127	100

Note: The ratings are based on 30^{0}C ambient air temperature and 15^{0}C ambient soil temperature

Table 27(1)

Rating Factors for Variations in Ambient Temperature for Cables in Air or Heated Concrete Slabs and for Cables Buried Direct in the Ground or in Underground Wiring Enclosures – Air And Concrete Slab Temperatures

1	2	3	4	5	6	7	8	9	10	11
Conductor temperature ^{0}C	Rating Factor Ambient temperature									
	15	20	25	30	35	40	45	50	55	60
150	1.07	1.05	1.03	1.00	0.98	0.96	0.94	0.91	0.89	0.87
110	1.08	1.06	1.03	1.00	0.97	0.93	0.90	0.87	0.83	0.79
90	1.15	1.09	1.05	1.00	0.95	0.91	0.85	0.80	0.74	0.66
80	1.17	1.12	1.06	1.00	0.95	0.89	0.82	0.75	0.68	0.59
75	1.18	1.12	1.06	1.00	0.94	0.88	0.80	0.72	0.63	0.53

Table 27(2)

Rating Factors for Variations in Ambient Temperature for Cables in Air or Heated Concrete Slabs and for Cables Buried Direct in the Ground or in Underground Wiring Enclosures – Soil Temperatures

1	2	3	4	5	6	7	8
Conductor temperature ^{0}C	**Rating Factor Ambient temperature**						
	10	**15**	**20**	**25**	**30**	**35**	**40**
110	1.02	1.00	0.97	0.94	0.92	0.89	0.86
90	1.04	1.00	0.96	0.93	0.91	0.87	0.83
80	1.04	1.00	0.95	0.92	0.88	0.83	0.78
75	1.04	1.00	0.95	0.91	0.86	0.81	0.75

Table 42

Three-Phase Voltage Drop at 50Hz of Multicore Cables with Circular Copper Conductors

Conductor size mm^2	**Three-phase voltage drop at 50 Hz, mV/A.m Conductor temperature, ^{0}C**									
	45		**60**		**75**		**90**		**110**	
	Max.	**0.8 p.f.**	**Max.**	**0.8 p.f.**	**Max.**	**0.8 p.f.**	**Max.**	**0.8 p.f.**	**Max.**	**0.8 p.f.**
1	40.3	-	42.5	-	44.7	-	46.8	-	49.7	-
1.5	25.9	-	27.3	-	28.6	-	30.0	-	31.9	-
2.5	14.1	-	14.9	-	15.6	-	16.4	-	17.4	-
4	8.77	-	9.24	-	9.71	-	10.2	-	10.8	-
6	5.86	-	6.18	-	6.49	-	6.80	-	7.22	-
10	3.49	-	3.67	-	3.86	-	4.05	-	4.29	-
16	2.19	-	2.31	-	2.43	-	2.55	-	2.70	-
25	1.39	-	1.47	-	1.54	-	1.61	-	1.71	-
35	1.01	-	1.06	-	1.11	-	1.17	-	1.24	-

Note: To convert to single-phase values multiply the three-phase value by 1.155

Question 6

Introduction

A three-phase 400V oven is to be installed in a restaurant. The electrician has calculated in accordance with Part 2 of AS/NZS 3000, that the minimum size cable that will meet all requirements is a 4mm2, 4 core, TPS copper cable. You have to confirm - or otherwise - using calculations that the 4 mm2, 4 core TPS copper cable is the minimum size cable that meets the load and voltage drop requirements.

(a) Calculate whether the 4mm2, 4 core, TPS copper cable meets the load requirements by using the information below and relevant information from **AS/NZS 3008.1.2 Table Set 2**

- The cable route length is 20 metres in length.
- The load is 25 kW
- The cable is fixed directly (touching).
- The ambient air temperature is 20°C.
- The voltage at the switchboard is 400 V.
- The permitted voltage drop from the switchboard to the oven must not exceed 1.5%
- The conductor temperature is assumed to be 75°C

(b) Calculate whether the 4mm2, 4 core, TPS copper cable meets the **voltage drop requirements** by using relevant information from **AS/NZS 3008.1.2 Table Set 2**

(c) Is the 4mm2, 4 core, TPS copper cable the minimum size cable that meets the load and voltage drop requirements? State a reason to support your answer.

Question 7

Introduction

You have been asked to install a 4-core neutral screened copper cable from a three-phase 400V, three-phase distribution panel to a three-phase, 400V service centre building in a ski-field. You need to find, by calculation the minimum size 4-core neutral screened copper cable that will meet the load and voltage drop requirements.

(a) Use the following information and information from **AS/NZS 3008.1.2 Table Set 2** and calculate the minimum size cable that will meet the loading requirements.

- The cable route length is 15.7 m.
- The service centre building load is 63 kW.
- The cable will be buried direct.
- The ambient soil temperature is 15°C.
- The voltage drop between distribution panel and the service centre switchboard must not exceed 2.5%.
- The conductor temperature is assumed to be 75°C

(b) Use **AS/NZS 3008.1.2 Table Set 2** calculate the minimum size cable that will meet the **voltage drop** requirements.

(c) State the minimum size 4-core neutral screened copper cable that will meet the **load** and **voltage drop** requirements.

Question 8

Introduction

It is proposed to install a three-phase, four-core copper cable to supply a low voltage, three-phase, 20kW motor. For this question you do not need to consider the power factor or efficiency of the motor.

(a) Load requirements

Use the following information and information from AS/NZS 3008.1.2 Table Set 2 to calculate the minimum size copper cable that will meet the load current requirements.

- The voltage at the switchboard is 400V
- The cable route between the switchboard and the motor is 60 metres.
- In the 1st half of the cable route, the cable will be completely surrounded by thermal insulation
- In the 2nd second half of the cable route, the cable will be surface clipped (touching).
- The maximum permitted voltage drop is 1%
- The conductor temperature is 75°C
- Allowance needs to be made for a 20% load increase (the circuit may supply a motor control panel in the future).

(b) Voltage drop requirements
Use information from AS/NZS 3008.1.2 Table Set 2 to calculate the minimum size copper cable that will meet the voltage drop requirements.

(c) State the minimum cable size that will meet both the load current and voltage drop requirements?

3. ECP 34

1. Metal poles for floodlights are being erected by a crane along a boundary fence of a sports field. There is an 11 kV overhead electric line supported by towers running parallel to and directly above the boundary fence. Refer to NZECP 34 and state the closest distance that the crane, and the crane's load (a metal pole), can be manoeuvred to the conductors of the 11 kV line:

(i) **Without** the consent of the owner of the 11 kV line.

……

REF_____

(ii) **With** the consent of the owner of the 11 kV line.

……

REF_____

2. Refer to NZECP 34 and state the minimum vertical distance from the ground of a 230 volt overhead sub-main:

(i) That crosses a footpath used only by pedestrians

……

REF_____

(ii) That crosses a driveway

……

REF_____

3. Refer to NZECP 34 and state TWO situations where compliance with the safe approach distances for persons is not required.

……

……

……

……

……

……

REF_____

4. A building is being constructed near an 11 kV overhead pole line with a span of 120 metres.

(i) Refer to NZECP 34 and state how close to the overhead line supports building construction can be carried out without prior written consent.

.....

REF_____

(ii) Refer to NZECP 34 and state the minimum distance to the side of a conductor of the overhead line from any part of the building once it has been completed.

.....

REF_____