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SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION

JANUARY 2010 SESSION

SUBJECT CODE	:	FED 10402
SUBJECT TITLE	:	ELECTRICAL DISTRIBUTION
LEVEL	:	DIPLOMA
TIME / DURATION	:	4.00pm – 6.00pm (3 HOURS) 2 H
DATE	:	04 MAY 2010

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This questions paper consists of TWO (2) sections. Section A and B. Answer ALL questions in section A. For sections B, answer TWO (2) questions only.
6. Answer all questions in English.

THERE ARE 6 PAGES OF QUESTIONS AND 12 PAGES OF APPENDICES, EXCLUDING THIS PAGE.

SECTION A (Total: 60 marks)

INSTRUCTION: Answer ALL questions.
Please use the answer booklet provided.

Question 1

(a) Define the main function of **turbine** in electrical power generation?

(2 marks)

(b) Give two examples of renewable energy and non renewable energy.

(4 marks)

(c) List three advantages three phase system upon the single phase system.

(3 marks)

(d) Figure 1 shows highly simplified process of converting uranium. States the processes are missing below and **explain** in simple sentences why we need those kinds of processes?

(6 marks)

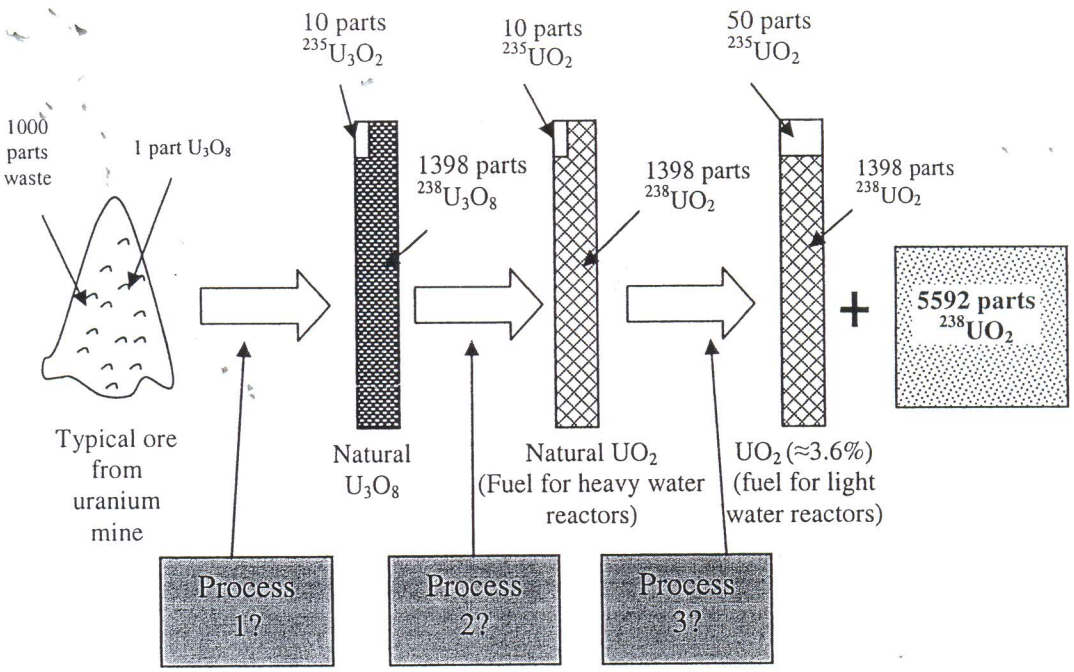


Figure 1

(e) Lists the three main components of a High Voltage Transmission Line.

(3 marks)

(f) Describe the main purpose of having a ground wire at the top of transmission lines.

(3 marks)

(g) Briefly explain the effect of corona and give the solution to diminish the corona effect.

(6 marks)

(h) Distribution system can be categorized into three connection system. State the three (3) systems.

(3 marks)

Question 2

A single storey house has a single phase, 240 V, 50 Hz supply with the following load :

- 14 x 40 W fluorescent lamps
- 5 x 20 W fluorescent lamps
- 4 x 100 W incandescent lamps
- 3 x 40 W ceiling fans
- 2 x 1.5 hp air conditioner
- 2 x 1 kW instantaneous water heater
- 1 x 4 kW electric cooker + 5 A Switch Socket Outlet
- 10 nos radial circuit feeding 13A socket outlet

The single core copper with P.V.C insulation cable will be run in an initial temperature of 30°C, it enclosed in the conduit to the floor joints for most of the 15 m cable run from the Main Switch Board (MSB) or consumer unit. Determine :

i. the maximum demand of the house (I_b) and the suitable rating of MCB (I_N).

(12 marks)

ii. the minimum size of cable with the requirement carrying capacity. (I_z and I_t)

(6 marks)

iii. the sizing of cpc (circuit protective conductor) cable

(3 marks)

iv. the suitable rating of RCD (residual current device) and main switch at the Main Switch Board (MSB).

(4 marks)

v. Draw a single line diagram for the power distribution of this house.

(5 marks)

(Refer to technical data attached for reference)

SECTION B (Total: 40 marks)

INSTRUCTION: Answer 2 questions only.
Please use the answer booklet provided.

Question 3

(a) In Table 1 below, are given some specification of the hydroelectric power station located in Savoie, France.

Power Station	Department	N	S	Cos φ	H	Q	W
La Bathie	Savoie	6	98	0.85	1200	50	900

Table 1

N = number of group turbine alternator
S (MVA) = apparent power of 1 group
Cos φ = power factor
H (m) = height of falling water
Q (m^3/s) = water flow
W (GWh) = annual production

Determine:

i. The input power of the turbine

(5 marks)

ii. the efficiency of the station

(5 marks)

(b) The monthly reading of a consumer meter is as follows :-

Maximum demand	60 kW
Energy consumed	24 000 kWh
Reactive energy	15 600 kVAR

i. Find the load factor and the power factor (p.f) of the load

(4 marks)

ii. If the tariff is RM 5 per kW maximum demand plus RM 0.20 per unit, calculate the monthly bill.

(3 marks)

iii. If the tariff is flat rate at RM 2 per kVA plus 0.30 per unit, what will be the monthly bill for this case?

(3 marks)

Question 4

(a) Protection devices are designed to disconnect the fault system elements with the electrical sources when there is an abnormal condition, state all 3 abnormal condition.

(3 marks)

(b) States three types of fuses are generally used.

(3 marks)

(c) Explain the advantage of using MCB as compared to fuse.

(4 marks)

(d) Refer to the diagram in Figure 2, explain the working principles of RCD in the healthy and faulty condition.

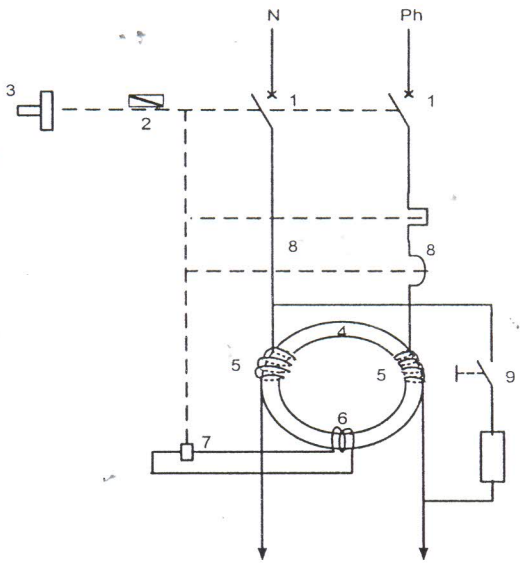


Figure 2

(6 marks)

(e) Explain the difference between **direct contact** and **indirect contact.** Give only one example.

(4 Marks)

Question 5

(a) State five types of earthing systems which have been discussed in IEE Regulation 16th Edition. Draw and explain only one type of the earthing system in detail.

(8 Marks)

(b) Describe the meaning of "solidly earthed" in the earthing system.

(2 Marks)

(c) Refer to the diagram in Figure 3. The voltage supply in each phase is 130 V.

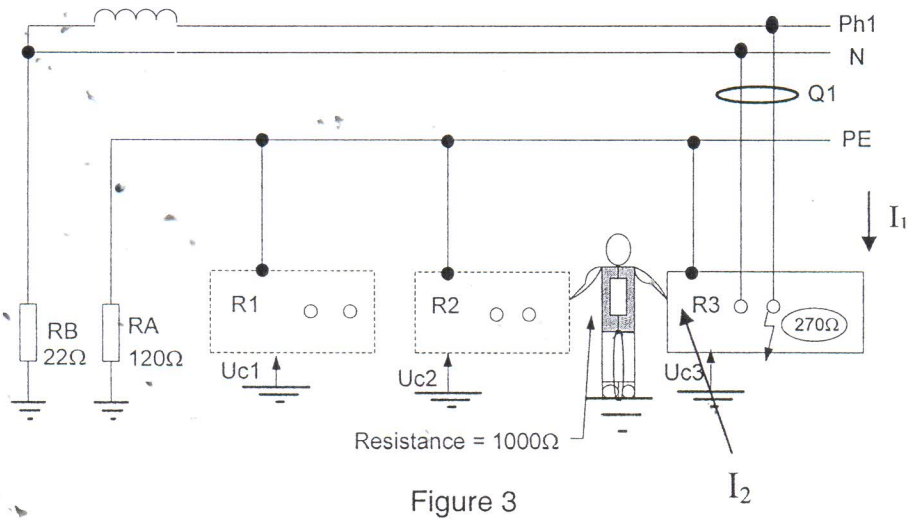


Figure 3

i. Determine the type of earthing system applied to the diagram in Figure 3. Justify your answer.

(4 marks)

ii. Calculate the value of voltage at Uc 1, Uc 2 and Uc 3 and give the limit voltage for every room, (U_L 1, U_L 2 & U_L 3).

(6 marks)

END OF QUESTION PAPER

APPENDICES / ATTACHMENT FILE

FED 10402 : ELECTRICAL DISTRIBUTION

LIST	CONTENTS
APPENDIX A	Table of Correction Factors for Ca,Cg & Ci
APPENDIX B	Table of Corrections Factors of Mineral insulated and Allowance for Diversity
APPENDIX C	Table 4A : Method of wiring installation
APPENDIX D	Table 4A : Method of wiring installation continued
APPENDIX E	Table 4D1A & Table 4D1B
APPENDIX F	Table 4D4A & Table 4D4B
APPENDIX G	Table 4F1A & Table 4F1B
APPENDIX H	Table 4F2A & Table 4F2B
APPENDIX I	Figure A : Time vs Current characteristics fuses to BS
APPENDIX J	Time vs Current characteristics MCB Type 1& Type 2 to BS 3871
APPENDIX K	Time vs Current characteristics MCB Type 3 & Type B to BS 3871
APPENDIX L	MCB Catalogue

APPENDIX A

TABLE 4C1

Correction factors for ambient temperature where protection is against short-circuit

NOTE: This table applies where the associated overcurrent protective device is intended to provide short-circuit protection only. Except where the device is a semi-enclosed fuse to BS 3036 the table also applies where the device is intended to provide overload protection.

Type of insulation	Operating temperature	Ambient temperature (°C)														
		25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
Rubber (flexible cables only)	60 °C	1.04	1.0	0.91	0.82	0.71	0.58	0.41	-	-	-	-	-	-	-	-
General purpose pvc	70 °C	1.03	1.0	0.94	0.87	0.79	0.71	0.61	0.50	0.35	-	-	-	-	-	-
Paper	80 °C	1.02	1.0	0.95	0.89	0.84	0.77	0.71	0.63	0.55	0.45	0.32	-	-	-	-
Rubber	85 °C	1.02	1.0	0.95	0.90	0.85	0.80	0.74	0.67	0.60	0.52	0.43	0.30	-	-	-
Heat resisting pvc*	90 °C	1.03	1.0	0.97	0.94	0.91	0.87	0.84	0.80	0.76	0.71	0.61	0.50	0.35	-	-
Thermosetting	90 °C	1.02	1.0	0.96	0.91	0.87	0.82	0.76	0.71	0.65	0.58	0.50	0.41	0.29	-	-
Mineral	70 °C sheath	1.03	1.0	0.93	0.85	0.77	0.67	0.57	0.45	0.31	-	-	-	-	-	-
	105 °C sheath	1.02	1.0	0.96	0.92	0.88	0.84	0.80	0.75	0.70	0.65	0.60	0.54	0.47	0.40	0.32

NOTES:

1. Correction factors for flexible cords and for 85 °C and 180 °C rubber-insulated flexible cables are given in the relevant table of current-carrying capacity.
2. This table also applies when determining the current-carrying capacity of a cable.
3. * These factors are applicable only to ratings in columns 2 to 5 of Table 4D1A.

TABLE 4B1

Correction factors for groups of more than one circuit of single-core cables, or more than one multicore cable (to be applied to the corresponding current-carrying capacity for a single circuit in Tables 4D1 to 4D4, 4E1 to 4E4, 4F1 and 4F2, 4J1, 4K1 to 4K4, 4L1 to 4L4)**

Reference method of installation (see Table 4A)		Correction factor (C_g) Number of circuits or multicore cables													
		2	3	4	5	6	7	8	9	10	12	14	16	18	20
Enclosed (Method 3 or 4) or bunched and clipped direct to a non-metallic surface (Method 1)		0.80	0.70	0.65	0.60	0.57	0.54	0.52	0.50	0.48	0.45	0.43	0.41	0.39	0.38
Single layer clipped to a non-metallic surface (Method 1)	Touching	0.85	0.79	0.75	0.73	0.72	0.72	0.71	0.70	-	-	-	-	-	-
	Spaced*	0.94	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Single layer *multicore* on a perforated metal cable tray, vertical or horizontal (Method 11)	Touching	0.86	0.81	0.77	0.75	0.74	0.73	0.73	0.72	0.71	0.70	-	-	-	-
	Spaced*#	0.91	0.89	0.88	0.87	0.87	-	-	-	-	-	-	-	-	-
Single layer *single-core* on a perforated metal cable tray, touching (Method 11)	Horizontal	0.90	0.85	-	-	-	-	-	-	-	-	-	-	-	-
	Vertical	0.85	-	-	-	-	-	-	-	-	-	-	-	-	-
Single layer multicore touching on ladder supports (Method 13)		0.86	0.82	0.80	0.79	0.78	0.78	0.78	0.77	-	-	-	-	-	-

* Spaced by a clearance between adjacent surfaces of at least one cable diameter (D_e). Where the horizontal clearances between adjacent cables exceeds 2 D_e no correction factor need be applied.

** When cables having differing conductor operating temperatures are grouped together, the current rating shall be based upon the lowest operating temperature of any cable in the group.

\- Correction factor not tabulated.

\# Not applicable to mineral insulated cables see Table 4B2.

Table 52A : Cable surrounded by thermal insulation (Ci)	
Length in insulation mm	Derating factor
50	0.89
100	0.81
200	0.68
400	0.55

APPENDIX B

Table 4B2 : Corrections factors for Mineral insulated cables installed on Performed Tray								
Tray Orientation	Arrangement of Cables	Number of Trays	Number of multicore cables of circuits					
			1	2	3	4	6	9
Horizontal	Multiconductor cables touching	1	1.0	0.90	0.80	0.80	0.75	0.75
Horizontal	Multiconductor cables spaced	1	1.0	1.0	1.0	0.95	0.90	-
Vertical	Multiconductor cables touching	1	1.0	0.90	0.80	0.75	0.75	0.70
Vertical	Multiconductoe cables spaced	1	1.0	0.90	0.90	0.90	0.85	-
Horizontal	Multiconductor cables trefoil separated	1	1.0	1.0	0.95			
Vertical	Multiconductor cables trefoil separated	1	1.0	0.90	0.90			

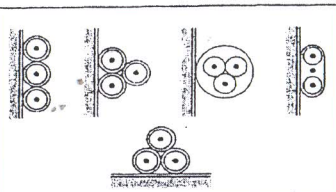
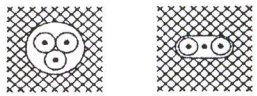
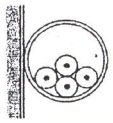
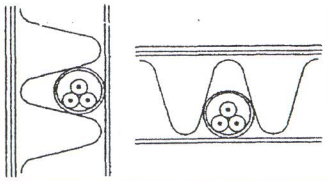
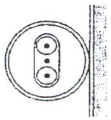
Maximum demand = Diversity allowance x Sum of total connected load

Table 6.2 - Allowance for diversity

Note the following abbreviations ;
X is the full load current of the largest appliance or circuit
Y is the full load current of the second largest appliance or circuit
Z is the full load current of the remaining appliances or circuits

Type of final circuit	Type of premises		
	Households	Small shops, stores, offices	Hotels, guest houses
Lighting	66% total demand	90% total demand	75% total demand
Heating and power	100% up to 10 A + 50% balance	100%X + 75%(Y+Z)	100%X + 80%Y + 60%Z
Cookers	10 A + 30% balance + 5 A for socket	100%X + 80%Y + 60%Z	100%X + 80%Y + 60%Z
Motors (but not lifts)		100%X + 80%Y + 60%Z	100%X + 50%(Y+Z)
Instantaneous water heaters	100%X + 100%Y + 25%Z	100%X + 100%Y + 25%Z	100%X + 100%Y + 25%Z
Thermostatic water heaters	100%	100%	100%
Floor warming installations	100%	100%	100%
Thermal storage heating	100%	100%	100%
Standard circuits	100%X + 40%(Y+Z)	100%X + 50%(Y+Z)	100%X + 50%(Y+Z)
Sockets and stationary equip.	100%X + 40%(Y+Z)	100%X + 75%(Y+Z)	100%X + 75%Y + 40%Z

TABLE 4A
Schedule of Installation Methods of Cables (including Reference Method)

Installation method		Examples	Appropriate Reference Method for determining current-carrying capacity
Number	Description		
1	2	3	4
Open and clipped direct:			
1	**Sheathed cables clipped direct to or lying on a non-metallic surface**		**Method 1**
Cables embedded direct in building materials:			
2	Sheathed cables embedded directly in masonry, brickwork, concrete, plaster or the like (other than thermally insulating materials)		Method 1
In conduit:			
3	**Single-core non-sheathed cables in metallic or non-metallic conduit on a wall or ceiling**		**Method 3**
4	**Single-core non-sheathed cables in metallic or non-metallic conduit in a thermally insulating wall or above a thermally insulating ceiling, the conduit being in contact with a thermally conductive surface on one side †**		**Method 4**
5	Multicore cables having non-metallic sheath, in metallic or non-metallic conduit on a wall or ceiling		Method 3

† The wall is assumed to consist of an outer weatherproof skin, thermal insulation and an inner skin of plasterboard or wood-like material having a coefficient of heat transfer not less than 10 W/m^{2}K. The conduit is fixed so as to be close to, but not necessarily touching, the inner skin. Heat from the cables is assumed to escape through the inner skin only.

TABLE 4A (continued)

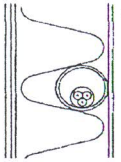
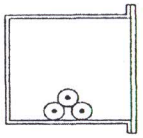
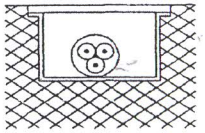
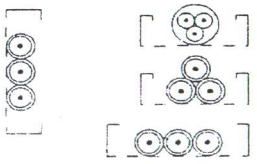
Installation method		Examples	Appropriate Reference Method for determining current-carrying capacity
Number	Description		
1	2	3	4
6	Sheathed cables in conduit in a thermally insulating wall etc. (otherwise as Reference Method 4)		Method 4
7	Cables in conduit embedded in masonry, brickwork, concrete, plaster or the like (other than thermally insulating materials)		Method 3
In trunking:			
8	Cables in trunking on a wall or suspended in the air		Method 3
9	Cables in flush floor trunking		Method 3
10	Single-core cables in skirting trunking		Method 3
On trays:			
11	**Sheathed cables on a perforated cable tray, bunched and unenclosed. A perforated cable tray is a ventilated tray in which the holes occupy 30 % or more of the surface area**		**Method 11**

TABLE 4A (continued)

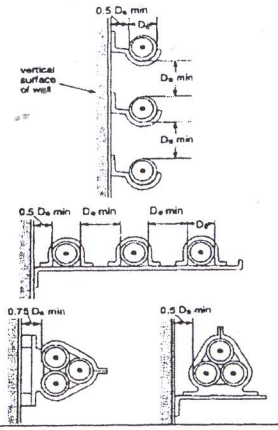
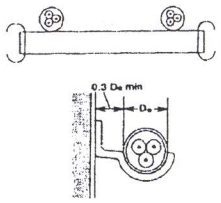
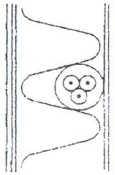
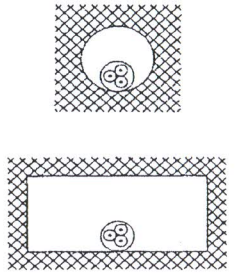
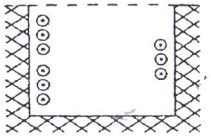
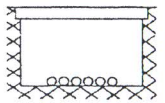
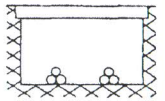
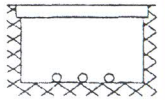
Installation method		Examples	Appropriate Reference Method for determining current-carrying capacity
Number	Description		
1	2	3	4
In free air, on cleats, brackets or a ladder:			
12	**Sheathed single-core cables in free air (any supporting metalwork under the cables occupying less than 10 % of the plan area):** **Two or three cables vertically one above the other, minimum distance between cable surfaces equal to the overall cable diameter (D_e); distance from the wall not less than 0.5 D_e** **Two or three cables horizontally, with spacings as above** **Three cables in trefoil, distance between wall and surface of nearest cable 0.5 D_e or nearest cables 0.75 D_e**		**Method 12**
13	**Sheathed multicore cables on ladder or brackets, separation greater than 2 D_e** **Sheathed multicore cables in free air distance between wall and cable surface not less than 0.3 D_e** **Any supporting metalwork under the cables occupying less than 10 % of the plan area**		**Method 13**
14	Cables suspended from or incorporating a catenary wire		Method 12 or 13, as appropriate
Cables in building voids:			
15	Sheathed cables installed directly in a thermally insulating wall or above a thermally insulating ceiling, the cable being in contact with a thermally conductive surface on one side (otherwise as Reference Method 4)		Method 4

TABLE 4A (continued)

Installation method		Examples	Appropriate Reference Method for determining current-carrying capacity
Number	Description		
1	2	3	4
16	Sheathed cables in ducts or voids formed by the building structure, other than thermally insulating materials		Method 4 Where the cable has a diameter D_e and the duct has a diameter not greater than 5 D_e or a perimeter not greater than 20 D_e Method 3 Where the duct has either a diameter greater than 5 D_e or a perimeter greater than 20 D_e NOTE 1 - Where the perimeter is greater than 60 D_e, installation Methods 18 to 20, as appropriate, should be used. NOTE 2 - D_e is the overall cable diameter. For groups of cables D_e is the sum of the cable diameters.
Cables in trenches:			
17	Cables supported on the wall of an open or ventilated trench, with spacings as indicated for Reference Method 12 or 13 as appropriate		Method 12 or 13, as appropriate
18	**Cables in enclosed trench 450 mm wide by 300 mm deep (minimum dimensions) including 100 mm cover**	Two single-core cables with surfaces separated by a minimum of one cable diameter.  Three single -core cables in trefoil and touching throughout.  Multicore cables or groups of single-core cables with surfaces separated by a minimum of 50 mm 	**Method 18** **Use rating factors in Table 4B3**

APPENDIX E

TABLE 4D1A

Single-core pvc-insulated cables, non-armoured, with or without sheath
(COPPER CONDUCTORS)

BS 6004
BS 6231
BS 6346

CURRENT CARRYING CAPACITY (amperes): Ambient temperature: 30 °C
Conductor operating temperature: 70 °C

Conductor cross-sectional area	Reference Method 4 (enclosed in conduit in thermally insulating wall etc.)		Reference Method 3 (enclosed in conduit on a wall or in trunking etc.)		Reference Method 1 (clipped direct)		Reference Method 11 (on a perforated cable tray horizontal or vertical)		Reference Method 12 (free air)		
									Horizontal flat spaced	Vertical flat spaced	Trefoil
	2 cables, single-phase a.c. or d.c.	3 or 4 cables, three-phase a.c.	2 cables, single-phase a.c. or d.c.	3 or 4 cables, three-phase a.c.	2 cables, single-phase a.c. or d.c. flat and touching	3 or 4 cables, three-phase a.c. flat and touching or trefoil	2 cables, single-phase a.c. or d.c. flat and touching	3 or 4 cables, three-phase a.c. flat and touching or trefoil	2 cables, single-phase a.c. or d.c. or 3 cables three-phase a.c.	2 cables, single-phase a.c. or d.c. or 3 cables three-phase a.c.	3 cables trefoil, three phase a.c.
1	2	3	4	5	6	7	8	9	10	11	12
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
1	11	10.5	13.5	12	15.5	14	-	-	-	-	-
1.5	14.5	13.5	17.5	15.5	20	18	-	-	-	-	-
2.5	19.5	18	24	21	27	25	-	-	-	-	-
4	26	24	32	28	37	33	-	-	-	-	-
6	34	31	41	36	47	43	-	-	-	-	-
10	46	42	57	50	65	59	-	-	-	-	-
16	61	56	76	68	87	79	-	-	-	-	-
25	80	73	101	89	114	104	126	112	146	130	110
35	99	89	125	110	141	129	156	141	181	162	137
50	119	108	151	134	182	167	191	172	219	197	167
70	151	136	192	171	234	214	246	223	281	254	216
95	182	164	232	207	284	261	300	273	341	311	264
120	210	188	269	239	330	303	349	318	396	362	308
150	240	216	300	262	381	349	404	369	456	419	356
185	273	245	341	296	436	400	463	424	521	480	409
240	320	286	400	346	515	472	549	504	615	569	485
300	367	328	458	394	594	545	635	584	709	659	561
400	-	-	546	467	694	634	732	679	852	795	656
500	-	-	626	533	792	723	835	778	982	920	749
630	-	-	720	611	904	826	953	892	1138	1070	855
800	-	-	-	-	1030	943	1086	1020	1265	1188	971
1000	-	-	-	-	1154	1058	1216	1149	1420	1337	1079

NOTES:
1. **Where the conductor is to be protected by a semi-enclosed fuse to BS 3036, see item 6.2 of the preface to this appendix.**
2. The current-carrying capacities in columns 2 to 5 are also applicable to flexible cables to BS 6004 table 1(2) and to 90 °C heat resisting pvc cables to BS 6231 tables 8 and 9 where the cables are used in fixed installations.

TABLE 4D1B

VOLTAGE DROP (per ampere per metre): Conductor operating temperature: 70 °C

Conductor cross-sectional area	2 cables d.c.	2 cables, single-phase a.c.									3 or 4 cables, three-phase a.c.											
		Reference Methods 3 & 4 (enclosed in conduit etc. in or on a wall)			Reference Methods 1 & 11 (clipped direct or on trays, touching)			Reference Method 12 (spaced*)			Reference Methods 3 & 4 (enclosed in conduit etc. in or on a wall)			Reference Methods 1, 11 & 12 (in trefoil)			Reference Methods 1 & 11 (flat and touching)			Reference Method 12 (flat spaced*)		
1	2	3			4			5			6			7			8			9		
(mm²)	(mV/A/m)	(mV/A/m)			(mV/A/m)			(mV/A/m)			(mV/A/m)			(mV/A/m)			(mV/A/m)			(mV/A/m)		
		r	x	z	r	x	z	r	x	z	r	x	z	r	x	z	r	x	z	r	x	z
1	44	44			44			44			38			38			38			38		
1.5	29	29			29			29			25			25			25			25		
2.5	18	18			18			18			15			15			15			15		
4	11	11			11			11			9.5			9.5			9.5			9.5		
6	7.3	7.3			7.3			7.3			6.4			6.4			6.4			6.4		
10	4.4	4.4			4.4			4.4			3.8			3.8			3.8			3.8		
16	2.8	2.8			2.8			2.8			2.4			2.4			2.4			2.4		
25	1.75	1.80	0.33	1.80	1.75	0.20	1.75	1.75	0.29	1.80	1.50	0.29	1.55	1.50	0.175	1.50	1.50	0.25	1.55	1.50	0.32	1.55
35	1.25	1.30	0.31	1.30	1.25	0.195	1.25	1.25	0.28	1.30	1.10	0.27	1.10	1.10	0.170	1.10	1.10	0.24	1.10	1.10	0.32	1.15
50	0.93	0.95	0.30	1.00	0.93	0.190	0.95	0.93	0.28	0.97	0.81	0.26	0.85	0.80	0.165	0.82	0.80	0.24	0.84	0.80	0.32	0.86
70	0.63	0.65	0.29	0.72	0.63	0.185	0.66	0.63	0.27	0.69	0.56	0.25	0.61	0.55	0.160	0.57	0.55	0.24	0.60	0.55	0.31	0.63
95	0.46	0.49	0.28	0.56	0.47	0.180	0.50	0.47	0.27	0.54	0.42	0.24	0.48	0.41	0.155	0.43	0.41	0.23	0.47	0.40	0.31	0.51
120	0.36	0.39	0.27	0.47	0.37	0.175	0.41	0.37	0.26	0.45	0.33	0.23	0.41	0.32	0.150	0.36	0.32	0.23	0.40	0.32	0.30	0.44
150	0.29	0.31	0.27	0.41	0.30	0.175	0.34	0.29	0.26	0.39	0.27	0.23	0.36	0.26	0.150	0.30	0.26	0.23	0.34	0.26	0.30	0.40
185	0.23	0.25	0.27	0.37	0.24	0.170	0.29	0.24	0.26	0.35	0.22	0.23	0.32	0.21	0.145	0.26	0.21	0.22	0.31	0.21	0.30	0.36
240	0.180	0.195	0.26	0.33	0.185	0.165	0.25	0.185	0.25	0.31	0.17	0.23	0.29	0.160	0.145	0.22	0.160	0.22	0.27	0.160	0.29	0.34
300	0.145	0.160	0.26	0.31	0.150	0.165	0.22	0.150	0.25	0.29	0.14	0.23	0.27	0.130	0.140	0.190	0.130	0.22	0.25	0.130	0.29	0.32
400	0.105	0.130	0.26	0.29	0.120	0.160	0.20	0.115	0.25	0.27	0.12	0.22	0.25	0.105	0.140	0.175	0.105	0.21	0.24	0.100	0.29	0.31
500	0.086	0.110	0.26	0.28	0.098	0.155	0.185	0.093	0.24	0.26	0.10	0.22	0.25	0.086	0.135	0.160	0.086	0.21	0.23	0.081	0.29	0.30
630	0.068	0.094	0.25	0.27	0.081	0.155	0.175	0.076	0.24	0.25	0.08	0.22	0.24	0.072	0.135	0.150	0.072	0.21	0.22	0.066	0.28	0.29
800	0.053				0.068	0.150	0.165	0.061	0.24	0.25				0.060	0.130	0.145	0.060	0.21	0.22	0.053	0.28	0.29
1000	0.042				0.059	0.150	0.160	0.050	0.24	0.24				0.052	0.130	0.140	0.052	0.20	0.21	0.044	0.28	0.28

NOTE: * Spacings larger than those specified in Method 12 (see table 4A) will result in larger voltage drop.

APPENDIX F

TABLE 4D4A
Multicore armoured pvc-insulated cables
(COPPER CONDUCTORS)

BS 6346

CURRENT-CARRYING CAPACITY (amperes): Ambient temperature: 30 °C
Conductor operating temperature: 70 °C

Conductor cross-sectional area	Reference Method 1 (clipped direct)		Reference Method 11 (on a perforated horizontal or vertical cable tray) or Reference Method 13 (free air)	
	1 two-core cable, single-phase a.c. or d.c.	1 three- or four-core cable, three-phase a.c.	1 two-core cable, single-phase a.c. or d.c.	1 three- or four-core cable, three-phase a.c.
1	2	3	4	5
(mm^2)	(A)	(A)	(A)	(A)
1.5	21	18	22	19
2.5	28	25	31	26
4	38	33	41	35
6	49	42	53	45
10	67	58	72	62
16	89	77	97	83
25	118	102	128	110
35	145	125	157	135
50	175	151	190	163
70	222	192	241	207
95	269	231	291	251
120	310	267	336	290
150	356	306	386	332
185	405	348	439	378
240	476	409	516	445
300	547	469	592	510
400	621	540	683	590

NOTE:
Where the conductor is to be protected by a semi-enclosed fuse to BS 3036, see item 6.2 of the preface to this appendix.

TABLE 4D4B

VOLTAGE DROP (per ampere per metre): Conductor operating temperature: 70 °C

Conductor cross-sectional area	Two-core cable, d.c.	Two-core cable, single-phase a.c.			Three- or four-core cable, three-phase a.c.		
1	2	3			4		
(mm^2)	(mV/A/m)	(mV/A/m)			(mV/A/m)		
1.5	29	29			25		
2.5	18	18			15		
4	11	11			9.5		
6	7.3	7.3			6.4		
10	4.4	4.4			3.8		
16	2.8	2.8			2.4		
		r	x	z	r	x	z
25	1.75	1.75	0.170	1.75	1.50	0.145	1.50
35	1.25	1.25	0.165	1.25	1.10	0.145	1.10
50	0.93	0.93	0.165	0.94	0.80	0.140	0.81
70	0.63	0.63	0.160	0.65	0.55	0.140	0.57
95	0.46	0.47	0.155	0.50	0.41	0.135	0.43
120	0.36	0.38	0.155	0.41	0.33	0.135	0.35
150	0.29	0.30	0.155	0.34	0.26	0.130	0.29
185	0.23	0.25	0.150	0.29	0.21	0.130	0.25
240	0.180	0.190	0.150	0.24	0.165	0.130	0.21
300	0.145	0.155	0.145	0.21	0.135	0.130	0.185
400	0.105	0.115	0.145	0.185	0.100	0.125	0.160

APPENDIX G

TABLE 4F1A
Single-core non-armoured cables having 85 °C rubber insulation
(COPPER CONDUCTORS)
BS 6007
BS 6883

CURRENT-CARRYING CAPACITY (amperes): Ambient temperature: 30 °C; Conductor operating temperature: 85 °C

Conductor cross-sectional area	Reference Method 3 (enclosed in conduit etc. in or on a wall)		Reference Method 1 (clipped direct)		Reference Method 11 (on a perforated cable tray) Horizontal or Vertical		Reference Method 12 (free air)	
	2 cables, single-phase a.c. or d.c.	3 or 4 cables, three-phase a.c.	2 cables, single-phase a.c. or d.c. flat and touching	3 or 4 cables, three-phase a.c. flat and touching or trefoil	2 cables, single-phase a.c. or d.c. flat and touching	3 or 4 cables, three-phase a.c. flat and touching or trefoil	2 cables, single-phase a.c. or d.c. or 3 or 4 cables, three-phase a.c. flat spaced horizontal or vertical	3 cables trefoil, three-phase a.c.
1	2	3	4	5	6	7	8	9
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
1	17	15	19	17.5	-	-	-	-
1.5	22	19.5	25	23	-	-	-	-
2.5	30	27	34	31	-	-	-	-
4	40	36	45	42	-	-	-	-
6	52	46	59	54	-	-	-	-
10	72	63	81	75	-	-	-	-
16	96	85	108	100	-	-	-	-
25	127	112	143	133	153	140	154	134
35	157	138	177	164	189	174	192	167
50	190	167	215	199	229	211	235	204
70	242	213	274	254	293	269	303	262
95	293	258	332	308	356	327	370	320
120	339	298	384	357	412	379	431	373
150	372	334	442	411	475	437	499	432
185	428	379	519	469	542	499	573	495
240	510	443	607	553	639	589	679	587
300	593	506	695	636	735	679	786	680
400	719	602	827	755	860	798	929	799
500	835	689	946	865	989	918	1081	919
630	975	791	1088	996	1143	1062	1263	1060

TABLE 4F1B

VOLTAGE DROP (per ampere per metre): Conductor operating temperature: 85 °C

Conductor cross-sectional area	2 cables, d.c.	2 cables, single-phase a.c.						3 or 4 cables, three-phase a.c.											
		Reference Method 3 (enclosed in conduit etc. in or on a wall)			Reference Methods 1 & 11 (clipped direct or on trays, touching)			Reference Method 12 (spaced*)			Reference Method 3 (enclosed in conduit etc. in or on a wall)			Reference Methods 1, 11 & 12 (in trefoil touching)			Reference Methods 1 & 11 (flat and touching)			Reference Method 12 (flat spaced*)		
1	2	3			4			5			6			7			8			9		
(mm²)	(mV/A/m)	(mV/A/m)			(mV/A/m)			(mV/A/m)			(mV/A/m)			(mV/A/m)			(mV/A/m)			(mV/A/m)		
1	46	46			46			-			40			40			40			-		
1.5	31	31			31			-			26			26			26			-		
2.5	18	18			18			-			16			16			16			-		
4	12	12			12			-			10			10			10			-		
6	7.7	7.7			7.7			-			6.7			6.7			6.7			-		
10	4.6	4.6			4.6			-			4.0			4.0			4.0			-		
16	2.9	2.9			2.9			-			2.5			2.5			2.5			-		
		r	x	z	r	x	z	r	x	z	r	x	z	r	x	z	r	x	z	r	x	z
25	1.80	1.85	0.32	1.90	1.85	0.20	1.85	1.85	0.29	1.85	1.60	0.28	1.65	1.60	0.175	1.60	1.60	0.25	1.60	1.60	0.32	1.65
35	1.30	1.35	0.31	1.40	1.30	0.195	1.35	1.30	0.28	1.35	1.15	0.27	1.20	1.15	0.170	1.15	1.15	0.24	1.15	1.15	0.32	1.20
50	0.95	1.00	0.30	1.05	0.97	0.190	0.99	0.97	0.28	1.00	0.87	0.26	0.91	0.84	0.165	0.86	0.84	0.24	0.88	0.84	0.32	0.90
70	0.65	0.68	0.29	0.74	0.66	0.185	0.69	0.66	0.27	0.72	0.60	0.25	0.65	0.57	0.160	0.60	0.57	0.24	0.62	0.57	0.31	0.65
95	0.48	0.51	0.28	0.58	0.49	0.180	0.52	0.49	0.27	0.56	0.44	0.25	0.51	0.43	0.155	0.45	0.43	0.23	0.48	0.42	0.31	0.52
120	0.38	0.40	0.27	0.49	0.39	0.175	0.43	0.39	0.26	0.47	0.35	0.24	0.43	0.34	0.155	0.37	0.34	0.23	0.41	0.34	0.30	0.45
150	0.30	0.33	0.27	0.42	0.31	0.175	0.35	0.31	0.26	0.40	0.29	0.24	0.37	0.27	0.150	0.31	0.27	0.23	0.35	0.27	0.30	0.40
185	0.25	0.27	0.27	0.38	0.25	0.170	0.30	0.25	0.26	0.36	0.23	0.23	0.33	0.22	0.150	0.26	0.22	0.22	0.31	0.22	0.30	0.37
240	0.190	0.21	0.26	0.33	0.195	0.165	0.26	0.195	0.25	0.32	0.180	0.23	0.29	0.170	0.145	0.22	0.170	0.22	0.28	0.170	0.30	0.34
300	0.150	0.170	0.26	0.31	0.155	0.165	0.23	0.155	0.25	0.29	0.150	0.23	0.27	0.135	0.140	0.195	0.135	0.22	0.26	0.135	0.29	0.32
400	0.115	0.140	0.26	0.30	0.125	0.160	0.20	0.120	0.25	0.28	0.130	0.22	0.26	0.110	0.140	0.175	0.110	0.21	0.24	0.105	0.29	0.31
500	0.091	0.115	0.26	0.28	0.100	0.155	0.185	0.097	0.24	0.26	0.105	0.22	0.24	0.089	0.135	0.165	0.089	0.21	0.23	0.085	0.29	0.30
630	0.072	0.100	0.25	0.27	0.082	0.155	0.175	0.077	0.24	0.25	0.085	0.22	0.24	0.073	0.135	0.155	0.073	0.21	0.22	0.067	0.28	0.29

NOTE: * Spacings larger than those specified in Method 12 (see table 4A) will result in larger voltage drop.

APPENDIX H

TABLE 4F2A

Multicore, sheathed and non-armoured cables having 85 °C rubber insulation (COPPER CONDUCTORS)

CURRENT-CARRYING CAPACITY (amperes): BS 6883 — Ambient temperature: 30 °C; Conductor operating temperature: 85 °C

Conductor cross-sectional area	Reference Method 3 (enclosed)		Reference Method 1 (clipped direct)		Reference Method 11 (on a perforated cable tray) or Reference Method 13 (free air)	
	1 two-core cable, single-phase a.c. or d.c.	1 three- or four-core cable, three-phase a.c.	1 two-core cable, single-phase a.c. or d.c.	1 three- or four-core cable, three-phase a.c.	1 two-core cable, single-phase a.c. or d.c.	1 three- or four-core cable, three-phase a.c.
1	2	3	4	5	6	7
(mm^2)	(A)	(A)	(A)	(A)	(A)	(A)
1	16.5	14.5	18	16	19.5	17.5
1.5	21	18.5	23	20	25	22
2.5	29	25	32	28	34	30
4	38	33	43	37	46	40
6	48	43	55	48	59	52
10	66	58	76	66	81	71
16	87	77	103	88	109	94
25	114	100	136	117	144	123
35	139	122	168	144	177	151
50	167	147	201	174	213	186
70	211	185	256	222	272	237
95	254	222	310	269	329	287
120	292	256	359	312	381	333
150	320	287	413	359	438	383
185	368	326	470	409	499	437
240	439	381	553	482	587	515
300	509	436	636	555	675	593

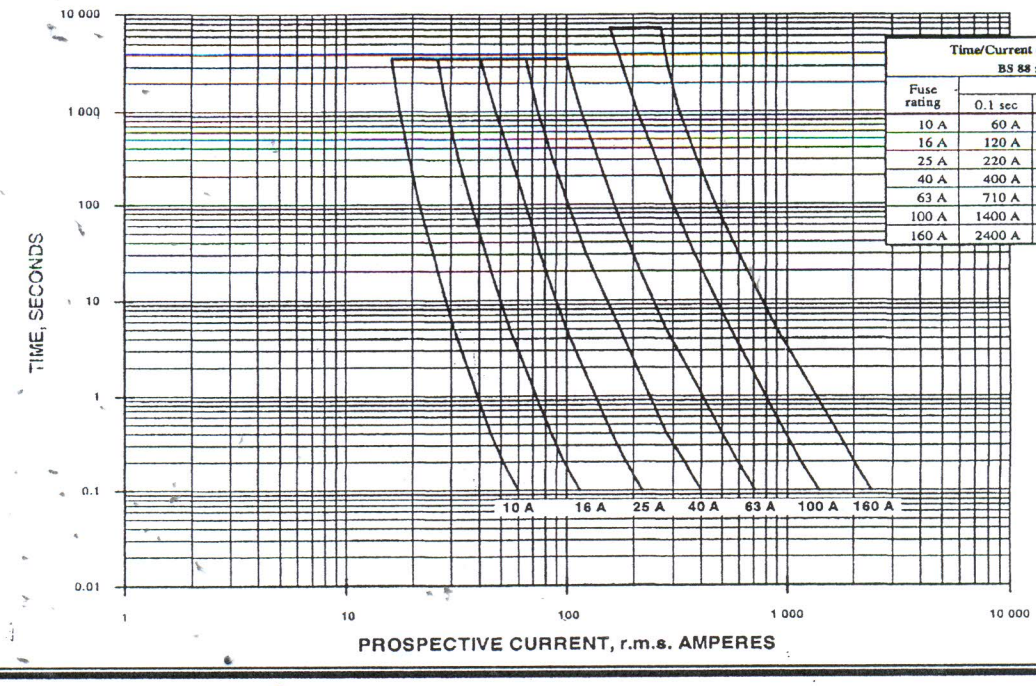
TABLE 4F2B

VOLTAGE DROP (per ampere per metre): Conductor operating temperature: 85 °C

Conductor cross-sectional area	Two-core cable, d.c.	Two-core cable, single-phase a.c.			Three- or four-core cable, three-phase a.c.		
1	2	3			4		
(mm^2)	(mV/A/m)	(mV/A/m)			(mV/A/m)		
1	46	46			40		
1.5	31	31			26		
2.5	19	19			16		
4	12	12			10		
6	7.7	7.7			6.7		
10	4.6	4.6			4.0		
16	2.9	2.9			2.5		
		r	x	z	r	x	z
25	1.80	1.85	0.175	1.85	1.60	0.150	1.60
35	1.30	1.30	0.170	1.35	1.15	0.150	1.15
50	0.95	0.97	0.170	0.99	0.84	0.145	0.86
70	0.65	0.66	0.165	0.68	0.58	0.140	0.59
95	0.48	0.49	0.160	0.52	0.43	0.140	0.45
120	0.38	0.39	0.160	0.42	0.34	0.135	0.36
150	0.30	0.31	0.155	0.35	0.27	0.135	0.30
185	0.25	0.25	0.155	0.30	0.22	0.130	0.26
240	0.190	0.195	0.150	0.25	0.170	0.130	0.22
300	0.150	0.155	0.150	0.22	0.135	0.130	0.185

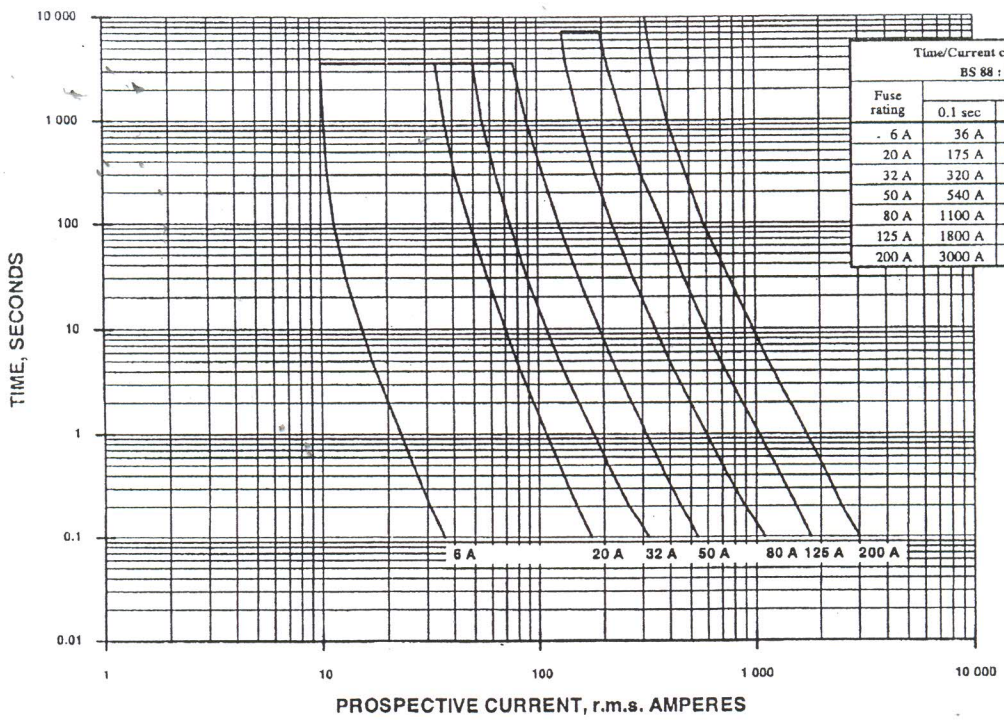
APPENDIX I

fig 3.3B **Fuses to BS 88 : Part 2 and Part 6**



Time/Current characteristics for fuses to BS 88 : Part 2 and Part 6				
Fuse rating	Current for time			
	0.1 sec	0.2 sec	0.4 sec	5 secs
10 A	60 A	51 A	45 A	31 A
16 A	120 A	95 A	85 A	55 A
25 A	220 A	180 A	160 A	100 A
40 A	400 A	340 A	280 A	170 A
63 A	710 A	590 A	500 A	280 A
100 A	1400 A	1150 A	980 A	550 A
160 A	2400 A	2000 A	1700 A	900 A

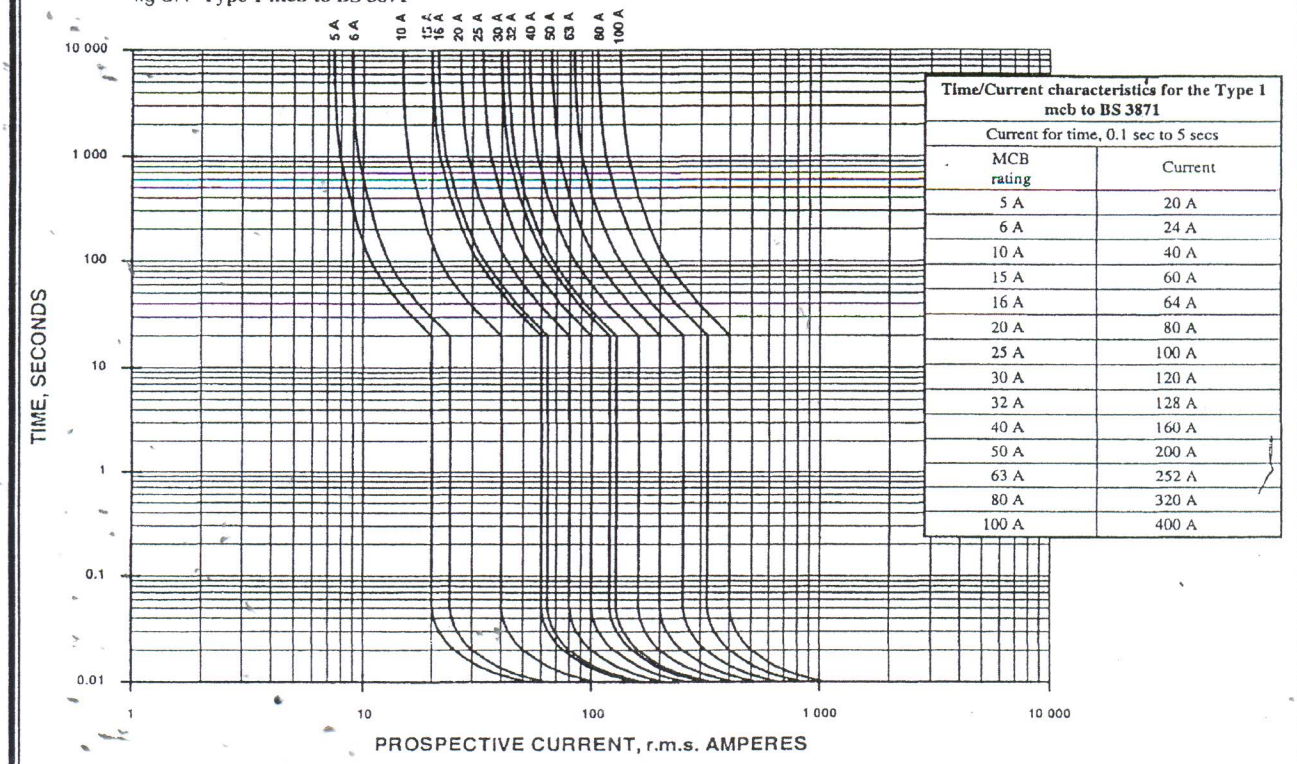
fig 3.3A **Fuses to BS 88 : Part 2 and Part 6**



Time/Current characteristics for fuses to BS 88 : Part 2 and Part 6				
Fuse rating	Current for time			
	0.1 sec	0.2 sec	0.4 sec	5 secs
6 A	36 A	31 A	27 A	17 A
20 A	175 A	150 A	130 A	79 A
32 A	320 A	260 A	220 A	125 A
50 A	540 A	450 A	380 A	220 A
80 A	1100 A	890 A	740 A	400 A
125 A	1800 A	1500 A	1300 A	690 A
200 A	3000 A	2500 A	2200 A	1200 A

APPENDIX I

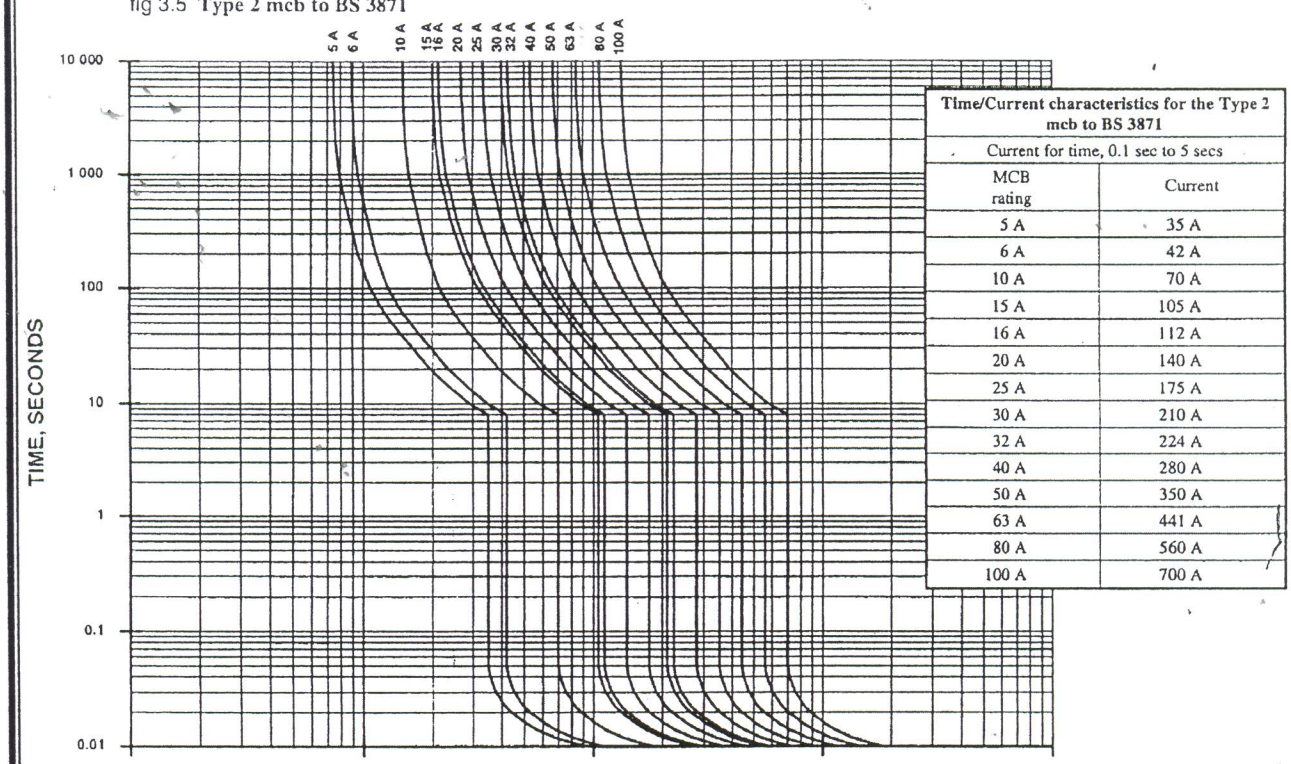
fig 3.4 **Type 1 mcb to BS 3871**



Time/Current characteristics for the Type 1 mcb to BS 3871

Current for time, 0.1 sec to 5 secs	
MCB rating	Current
5 A	20 A
6 A	24 A
10 A	40 A
15 A	60 A
16 A	64 A
20 A	80 A
25 A	100 A
30 A	120 A
32 A	128 A
40 A	160 A
50 A	200 A
63 A	252 A
80 A	320 A
100 A	400 A

fig 3.5 **Type 2 mcb to BS 3871**

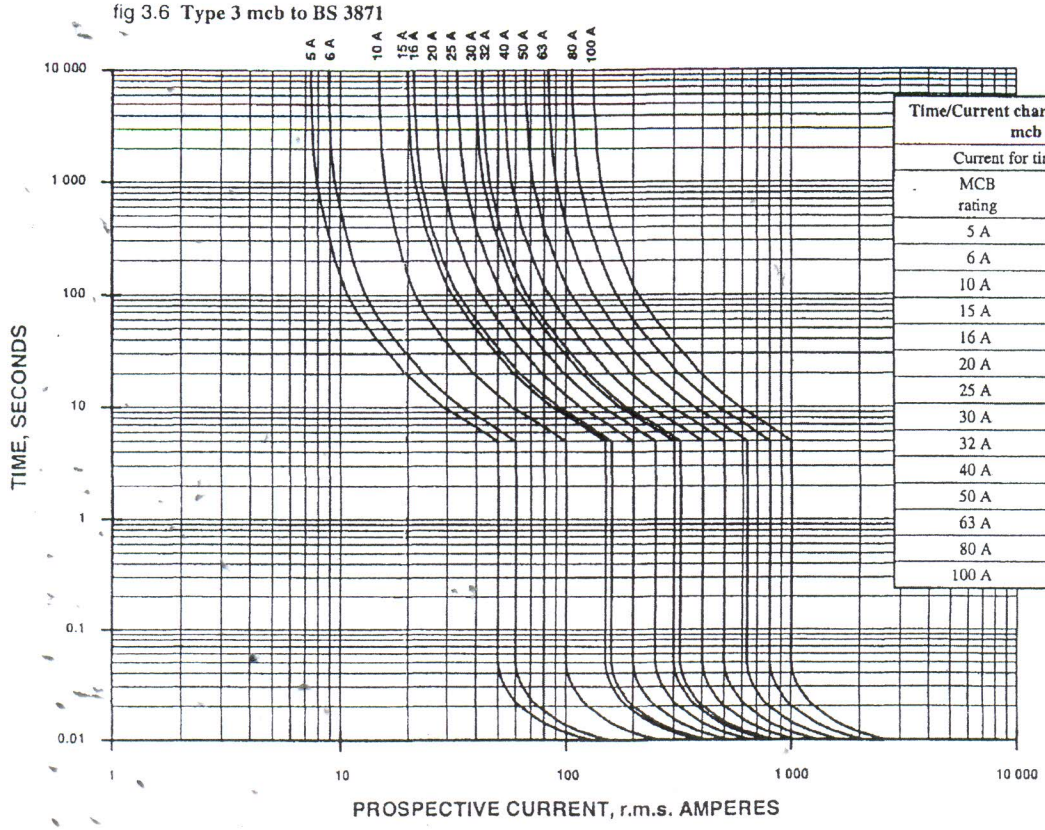


Time/Current characteristics for the Type 2 mcb to BS 3871

Current for time, 0.1 sec to 5 secs	
MCB rating	Current
5 A	35 A
6 A	42 A
10 A	70 A
15 A	105 A
16 A	112 A
20 A	140 A
25 A	175 A
30 A	210 A
32 A	224 A
40 A	280 A
50 A	350 A
63 A	441 A
80 A	560 A
100 A	700 A

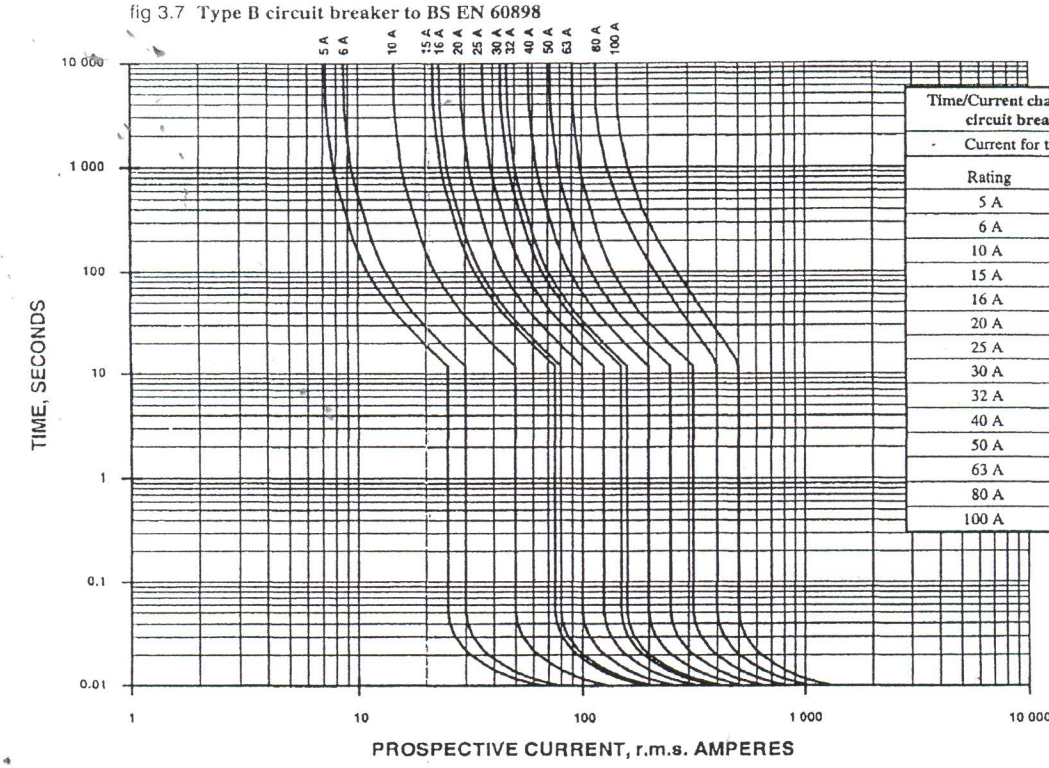
APPENDIX K

fig 3.6 Type 3 mcb to BS 3871



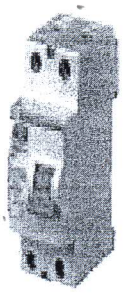
Time/Current characteristics for the Type 3 mcb to BS 3871	
Current for time, 0.1 sec to 5 secs	
MCB rating	Current
5 A	50 A
6 A	60 A
10 A	100 A
15 A	150 A
16 A	160 A
20 A	200 A
25 A	250 A
30 A	300 A
32 A	320 A
40 A	400 A
50 A	500 A
63 A	630 A
80 A	800 A
100 A	1000 A

fig 3.7 Type B circuit breaker to BS EN 60898

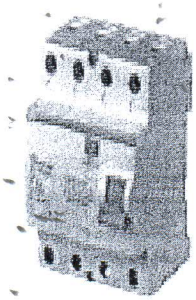


Time/Current characteristics for the Type B circuit breaker to BS EN 60898	
Current for time, 0.1 sec to 5 secs	
Rating	Current
5 A	25 A
6 A	30 A
10 A	50 A
15 A	75 A
16 A	80 A
20 A	100 A
25 A	125 A
30 A	150 A
32 A	160 A
40 A	200 A
50 A	250 A
63 A	315 A
80 A	400 A
100 A	500 A

APPENDIX L



F202, F672



F204, F674

Residual current devices

Breaker		GF trip level	Rated current	Catalog number	List price	Delivery class	Suggested order qty	Wgt. oz (1 Pc.)
F202	Two pole	10mA	16	F202AC-16/0.01	$ 500			
F672	480Y/277VAC	30mA	25	F202AC-25/0.03	300			
			40	F202AC-40/0.03	400			
			63	F202AC-63/0.03	550			
			80	F672-80/0.03	1600			
			100	F672-100/0.03	2200			
		100mA	25	F202AC-25/0.1	300			
			40	F202AC-40/0.1	400	B	1	13.8
			63	F202AC-63/0.1	550			
			80	F672-80/0.1	1600			
			100	F672-100/0.1	2200			
		300mA	25	F202AC-25/0.3	300			
			40	F202AC-40/0.3	400			
			63	F202AC-63/0.3	550			
			80	F672-80/0.3	1300			
			100	F672-100/0.3	1800			
F204	Four pole	30mA	25	F204AC-25/0.03	350			
F674	480Y/277VAC		40	F204AC-40/0.03	450			
			63	F204AC-63/0.03	600			
			80	F674-80/0.03	1300			
			100	F674-100/0.03	1800			
			125	F674-125/0.03	1800			
		100mA	25	F204AC-25/0.1	350			
			40	F204AC-40/0.1	450			
			63	F204AC-63/0.1	600			
			80	F674-80/0.1	1300			
			100	F674-100/0.1	1800	B	1	19.0
			125	F674-125/0.1	1800			
		300mA	25	F204AC-25/0.3	350			
			40	F204AC-40/0.3	450			
			63	F204AC-63/0.3	600			
			80	F674-80/0.3	1200			
			100	F674-100/0.3	1800			
			125	F674-125/0.3	1800			
		500mA	25	F204AC-25/0.5	450			
			40	F204AC-40/0.5	600			
			63	F204AC-63/0.5	650			

Above devices are UL 1053 recognized and IEC 1008 approved.

Delivery Class

A - Standard item, stock to 2 weeks lead time
B - Stock to 4 weeks lead time
C - 6 to 8 week lead time

END OF TECHNICAL DOCUMENTATION