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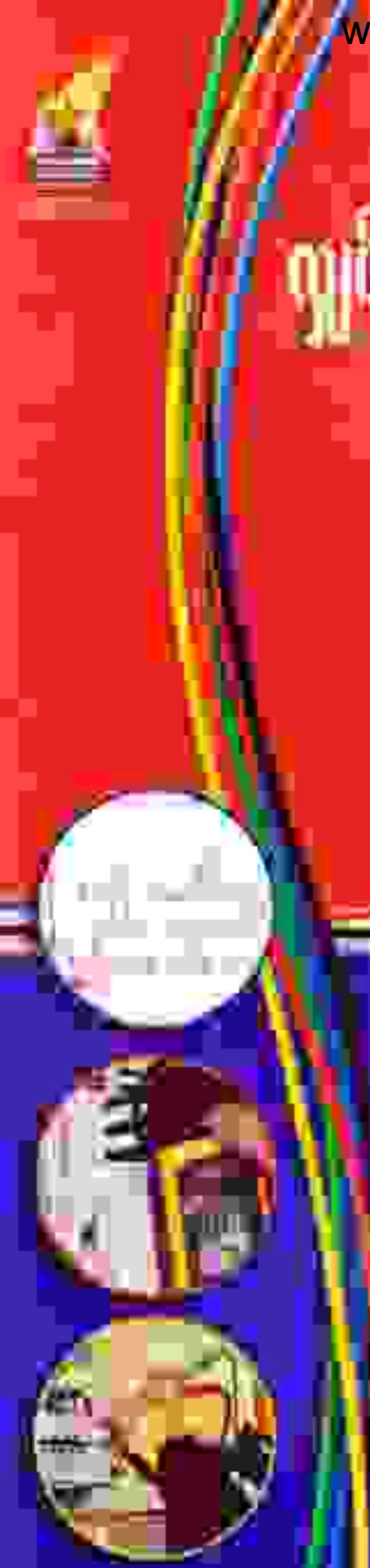

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CHAPTER I

Calculation Of The Cross Sectional Area Of Circuit Live Conductor

1. Chapter I-အခန်းအကြောင်း
2. ဆားကစ်တွက်ချက်ခြင်းဖြင့် circuit တစ်ခုအတွက် လိုအပ်သော phase cable ဝိုင်ယာအရွယ်အစား
   Example I-1
   Example I-2
   Example I-3
3. Circuit is thermally insulating walls
   အပူလေထုဆိုင်ရာခံနိုင်ရည်ရှိသော material များဖြင့်ပြုလုပ်ထားသော နံရံ
   များပေါ်တွင် circuit၏ cable ဝိုင်ယာများ တပ်ဆင်ခြင်းအတွက် cable ဝိုင်ယာအရွယ်အစား
   Example I-4
4. Circuit totally surrounded by thermally insulating material
   Circuit တစ်ခု သုတ်ခြောက်ထားသော cable ဝိုင်ယာများ ပူလောင်မှုခံနိုင်ရည်ရှိသော
   (thermal insulating material) တစ်ခုခုဖြင့် cable ဝိုင်ယာ တစ်ခုလုံးကို ဖုံးလွှမ်းထားခြင်း
   Example I-5
5. Circuit is partly surrounded by thermally insulating material
   ဂျင်း၏ cable ဝိုင်ယာများ တစ်စိတ်တစ်ပိုင်းတွင် ပူလောင်မှုခံနိုင်ရည်ရှိသော material
   များဖြင့် ဖုံးလွှမ်းထားခြင်းနှင့် ကျန်ရှိသော cable ဝိုင်ယာများ ဖုံးလွှမ်းမထားခြင်း
   Example I-6
   Example I-7
6. Circuits in conduit
   ပတ်ဝန်းကျင်အပူချိန် ၃၀ ဒီဂရီစင်တီဂရိတ်ရှိသော နေရာတွင် တပ်ဆင်ထားသော
   Trunking ဝိုင်ယာများ
   Example I-8
   Example I-9
7. Circuits in trunking
   enclosed in thermal insulation
   Example I-10
   Example I-11
8. Circuits of multicore armoured cable
   ကြေးနီကြိုးများဖြင့် ပြုလုပ်ထားသော circuit များ ဝိုင်ယာများ
   cable ဝိုင်ယာများ
   Example I-12
9. Circuit in conduit
   ပတ်ဝန်းကျင်အပူချိန် ၃၀ ဒီဂရီစင်တီဂရိတ်ရှိသော နေရာတွင် circuit ၏ cable ဝိုင်ယာများ ပြုပြင်ထားခြင်းများ
   ဖြစ်သော
   Trunking ဝိုင်ယာများ
   Example I-13

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10 [illegible]

Example 1-14 [illegible]

Example 1-15 [illegible]

11 [illegible]

Example 1-16 [illegible]

12. [illegible]

Example 1-17 [illegible]

Example 1-18 [illegible]

13 [illegible]

Example 1-19 [illegible]

14. [illegible]

Example 1-20 [illegible]

Example 1-21 [illegible]

Example 1-22 [illegible]

Example 1-23 [illegible]

15. [illegible]

[illegible]

CHAPTER 2

CALCULATION OF VOLTAGE DROP UNDER NORMAL LOAD CONDITION [illegible]

1. Chapter 2 [illegible]

2. Voltage drop [illegible]

3. The simple approach

[illegible] voltage drop [illegible]

Example 2-1 [illegible]

Example 2-2 [illegible]

Example 2-3 [illegible]

Example 2-4 [illegible]

4. The more accurate approach taking account of [illegible]

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Example 2-18 ...
14 ...
Example 2-19 ...
Example 2-20 ...
Example 2-21 ...
15. On-line guide, BS7671: 2008 (2011) y Tables ...
16. On-line guide, BS7671: 2008 (2011) ...
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Example 2-24 ...

CHAPTER 3

Calculation of Earth Fault Loop Impedance

1 Chapter 3 ...
2. BS7671 ... Fuse ...
3. ... earth fault loop impedance ...
... (Zs) ... BS7671 ... difficult ...
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Example 3-2 ...
4. ... (Zs) ... BS7671 ... protective device (fuse and breaker) ... live ... neutral ... and earth fault loop impedance ...
Example 3-3 ...
5. ... and earth fault loop impedance ... earth ... Zs ... BS7671 ... (387) ... Table 4 (... (388) Table 41.3 ...
Example 3-4 ...
6. The term ... circuit ... earth fault loop impedance ... circuit ... cable ... earth fault loop impedance ...
Example 3-5 ...
7. ... (Zs) ... protective device ... cable ... and earth fault loop impedance ...
Example 3-6 ...
8. earth fault ... circuit ... cable ... BS7671 ... Appendix 1 ... earth fault loop impedance ...

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6 Calculation When The Protective Device is an MCB

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Example 4-6

7. Example 4-7

8 RCCB (residual current operated circuit breaker)

9. Example 4-8

Example 4-9

10. Example 4-10

11. Example 4-11

Example 4-12

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1 Calculations Related Short Circuit Conditions

2. Short circuit

3.

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Example 5-2

Example 5-3

4 Example 5-4

5. The

Example 5-5

Example 5-6

6 Circuit

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Definitions
Coordinate system

REGULATION

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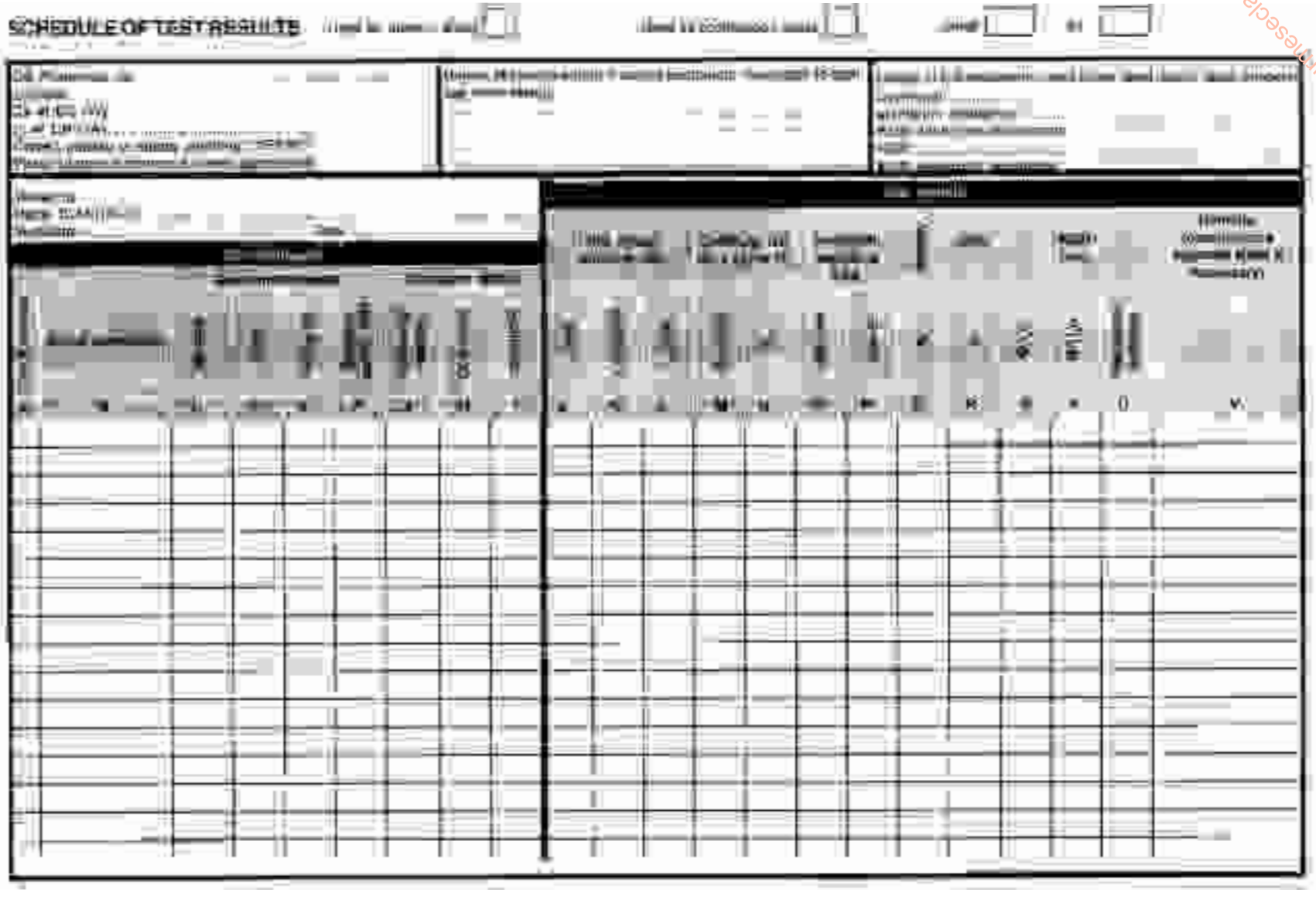

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CHAPTER-1

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[redacted]

THE SIMPLE APPROACH

[redacted]

Example 1-1

[redacted]

ဆိုင်း(၁) I_t ကောက်ထွင် အသုံးပြုမည့် BS 88 "ဂ/၂" fuse ၏ သွယ်ဝိုက်အတိမ်နက်ဆုံး (minimum rating) တန်ဖိုးကိုရှာပြီး

ဆိုင်း(၂) I_t တန်ဖိုးရလာသည့်အတွက် current ဆောင်ကျဉ်းပြုထားသော protective type အမျိုးအစား I_n တန်ဖိုးကိုရွေးပြီး

ဆိုင်း(၃) I_t (circuit သတ္တိ) ထိသော cable ကြိုးအင်ဇင်းစားမှုကို လျှပ်စီးစားတန်ဖိုးရှာပြီး

ဆိုင်း(၄) cable ကြိုးအင်ဇင်းစားမှုနှုန်းအတွက် circuit တွင် အသုံးပြုသော ကားကာ ကြိုးကျော်ကောင့် အတည်ဆိုင်းထား BS 7671 ၏ Appendix 4 current-carrying capacity table များမှယူပြီး

ဆိုင်း(၅) ဤအဆင့်တွင်းတွင် current-carrying capacity table မှ တတိယတိုင်းတန်းစားမှုယူပြီး

ဆိုင်း(၆) ဤအဆင့်တွင်းတွင် current carrying capacity ၏ တတိယတိုင်းတန်း I_z နှင့် တတိယဆိုင်းတွင် ရရှိခဲ့သည့် circuit အတွက် သိထားသော cable ကြိုးတို့နှင့် နှိုင်းစားကြည့်ပါ။

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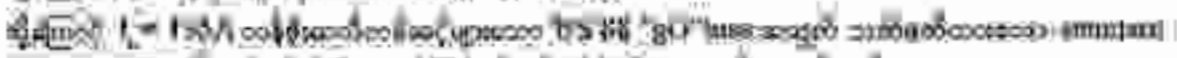

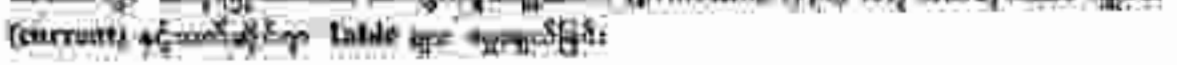

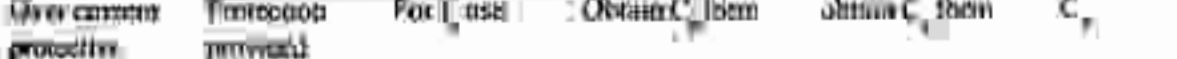

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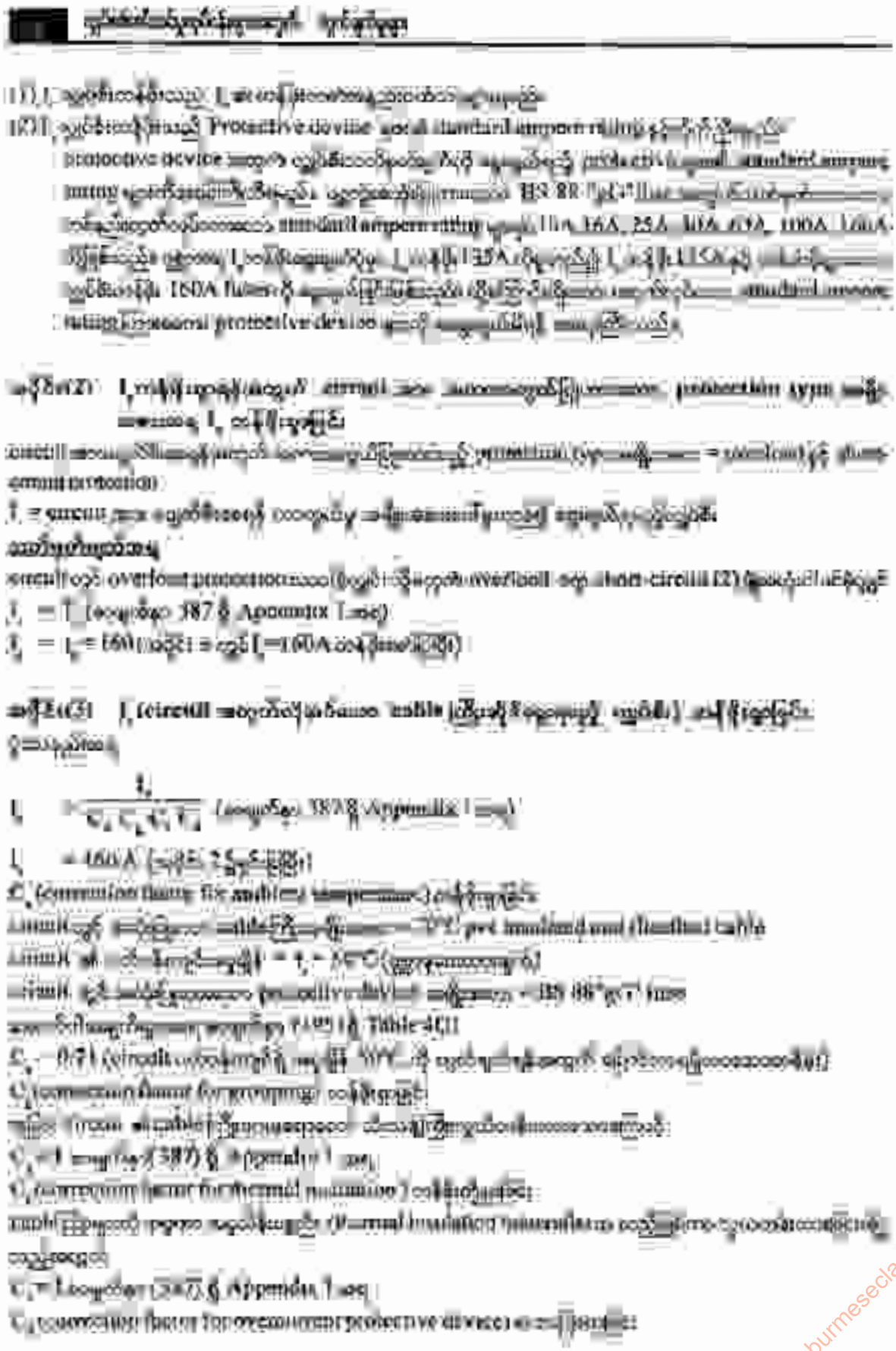

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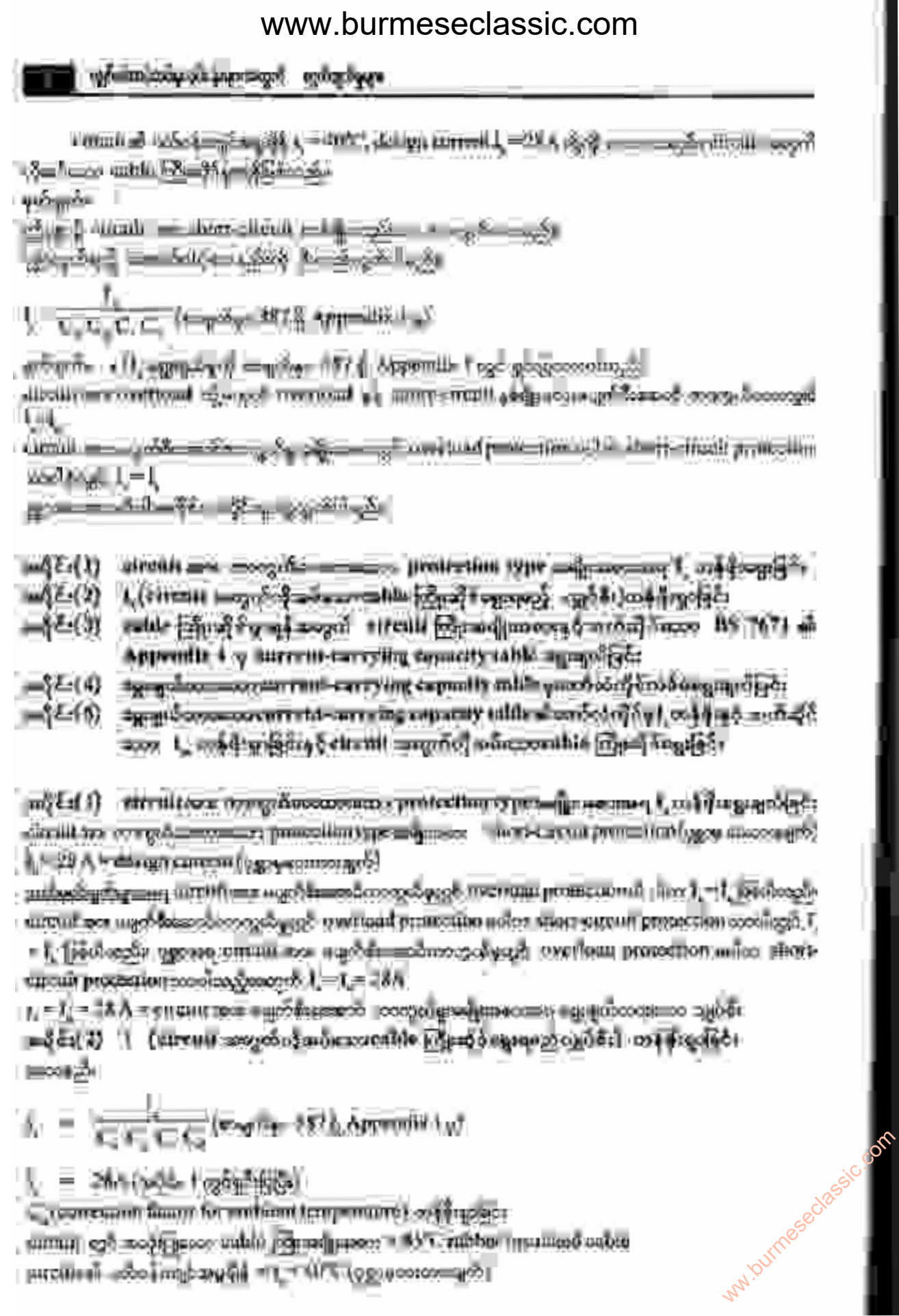

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Example 13

BS3036 fuse

Solution

Solution

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[illegible]

[illegible]

[illegible]

$$I_n = \frac{I_s}{C_1 C_2 C_3 C_4}$$ [illegible]

[illegible]

[illegible]

[

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[illegible]

[illegible]

[illegible]

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CIRCUITS TOTALLY SURROUNDED BY THERMALLY INSULATING MATERIALS

Example 1.5

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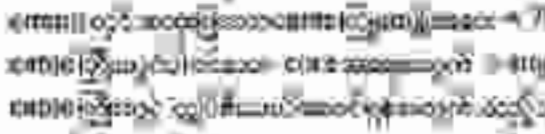

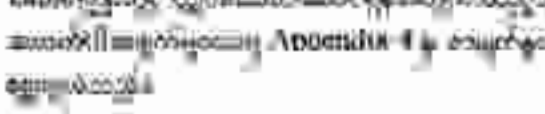

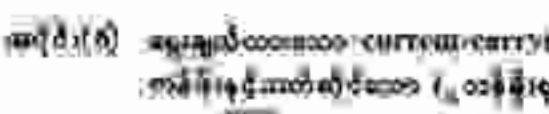

CIRCUITS IN VARYING EXTERNAL INFLUENCES AND INSTALLING CONDITION

Example 1.6.

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Example 6-7

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[redacted]

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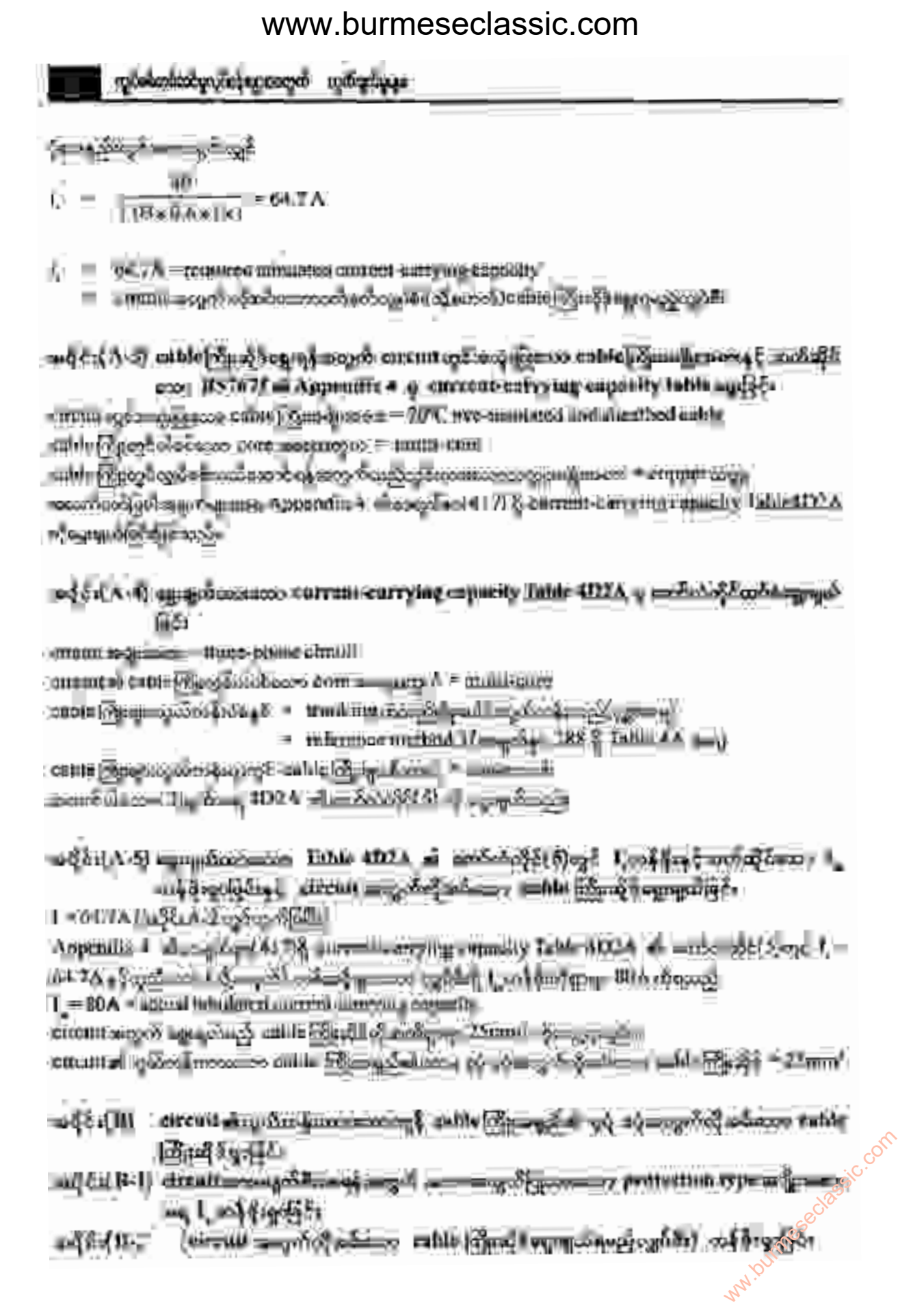

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[illegible] cable [illegible] circuit [illegible] cable [illegible]
[illegible] BS7671 [illegible] Appendix 4 [illegible] current-carrying capacity [illegible]
[illegible]

[illegible] equipotential current-carrying capacity [illegible]

[illegible] equipotential current-carrying capacity [illegible]

[illegible] current [illegible] [illegible] protective type [illegible]
[illegible]

[illegible]

[illegible] [illegible] [illegible] cable [illegible]

[illegible]

$$I_c = \frac{I_t}{C_a \times C_g \times \dots} \quad \text{[illegible] BS7671 Appendix 4}$$

I_t = [illegible]

[illegible]

[illegible] = 0.79 [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

C_g = [illegible] Appendix 4 [illegible]

[illegible]

$$I_t = \frac{\square}{\square \times \square \times \square} = \square\ \text{A}$$

I_t = [illegible]

= [illegible]

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CIRCUIT IN VENTILATED TRENCHES

[illegible]

Example 1.6

[illegible]

ပုစ္ဆာဝန်ထမ်းတို့ အောင်ဆောင်ရွက်ပေးပါသည်။

အပိုဒ်(1) circuit အားလုံးတို့ဟာ protection type အမျိုးအစားနဲ့ I_n အချိုးအစားများကို

အပိုဒ်(2) I_n [illegible] ကြိုးဆိုင်းဆွဲရာမှာသုံးတဲ့ဝါယာ) တန်ဖိုးကိုပြော

အပိုဒ်(3) cable ကြိုးဆိုင်းဆွဲရန်အတွက် circuit တွင် အသုံးပြုသော cable ကြိုးအမျိုးအစားနှင့် သက်ဆိုင်ရာ BS 7671 ၏ Appendix 4 မှ current-carrying capacity table များကိုပြော

အပိုဒ်(4) ရွေးချယ်ထားသော current-carrying capacity table မှ အတိအကျဖိုင်ဆိုပြော

အပိုဒ်(5) ရွေးချယ်ထားသော current-carrying capacity table၏ ဆက်သွယ်ဖိုင်မှ I_z တန်ဖိုးနှင့် သက်ဆိုင်သော I_n တန်ဖိုးများကိုနှိုင်းယှဉ်ပြော [illegible] ကြိုးဆိုင်းဆွဲရမည်ဖြစ်ကြောင်း

အပိုဒ်(6) circuit အား ကျော်လွန်ဆောင်ရွက်သော ဆောင်ရွက်ပြီးဆောင်ရွက်ပြီးသော protection type အမျိုးအစား I_n တန်ဖိုးများကိုပြော

[illegible]

[illegible]

[illegible]

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[illegible]

$$I = \frac{175}{1.73 \times 1 \times 1} = 246.5\,A$$

[illegible]

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[illegible] Appendix [illegible] current-carrying capacity Table 4D1A [illegible]
[illegible]

ဖြေရှင်း(4) [illegible] current-carrying capacity Table 4D1A [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

ဖြေရှင်း(5) [illegible] current-carrying capacity Table 4D1A [illegible]
[illegible]
[illegible]
Appendix [illegible] current-carrying capacity Table 4D1A [illegible]
[illegible]
[illegible]
[illegible]

Example 2-9

[illegible]

Circuit [illegible]

[illegible]

ဖြေရှင်း(1) [illegible]
[illegible]

ဖြေရှင်း(2) [illegible]

ဖြေရှင်း(3) [illegible]
[illegible] Appendix [illegible] current-carrying capacity [illegible]

ဖြေရှင်း(4) [illegible]

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$$I_z = \frac{I_n}{C_1 C_2 C_3} = \frac{63}{0.96 \times 1 \times 1} = 67A$$

I_z = 67A = required tabulated current-carrying capacity

ဥပမာ(3) cable တစ်ခုကို ... current ... cable ...

... BS 7671 ... Appendix 4 ... current-carrying capacity ...

... cable ... PVC ... non-armoured ...

... multi-core

... Appendix 4 ... current-carrying capacity Table 4D2A ...

ဖြေရှင်း(i) ... current-carrying capacity Table 4D2A ...

circuit = Three-phase circuit

circuit ... core ... = multi-core

cable ... = reference method 13

cable ... = vertically flat ...

... Table 4D2A ...

ဖြေရှင်း(ii) ... current-carrying capacity Table 4D2A ... (i) ... I_z ... circuit ... cable ...

I_z = 67A (ယခင်က ရရှိခဲ့သော)

Appendix 4 ... (417) ... current-carrying capacity ... Table 4D2A ... I_z = 67A ... I_n = 80A ...

I_n = 80A ... 16mm² ...

... circuit ... cable ... = 16mm²

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Example 1-10

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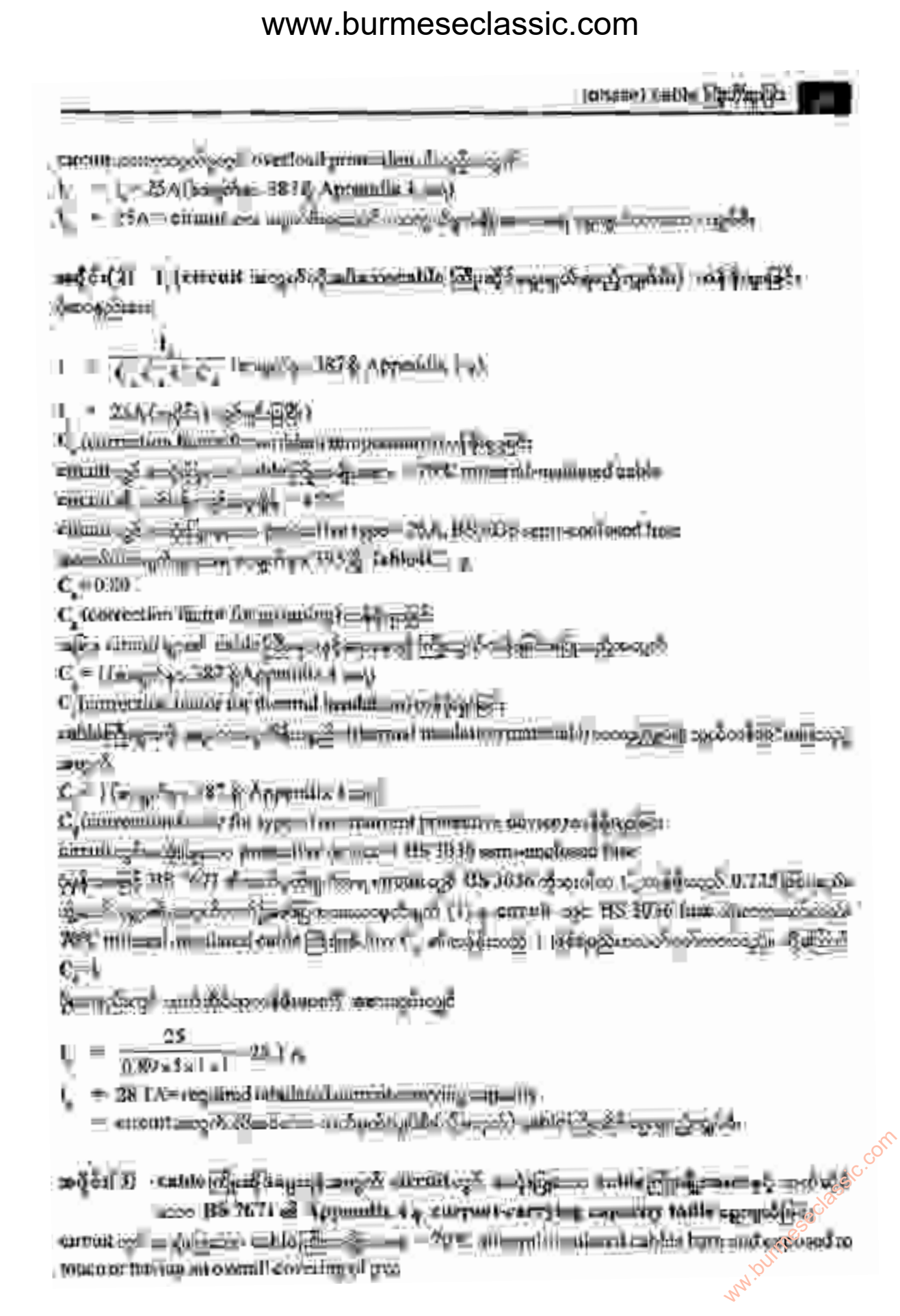

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[illegible]

CIRCUIT ON PERFORATED METAL CABLE TRAYS

[illegible]

Example 1-12

[illegible]

ဥပမာ(၁၂)

[illegible]

အပိုင်း(၁) [illegible]

အပိုင်း(၂) [illegible]

အပိုင်း(၃) [illegible]

အပိုင်း(၄) [illegible]

အပိုင်း(၅) [illegible]

အပိုင်း(၆) [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

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[redacted]

$$I_b = \frac{I_n}{C_1 C_2 \dots C_n}$$ [redacted]

I_n = 50A [redacted]

C_a correction factor for ambient temperature [redacted]

circuit [redacted] cable [redacted] = 0.87, rubber insulated non-armoured cable

circuit [redacted] = 0.87, [redacted]

circuit [redacted] protective device [redacted] = mcb

[redacted] 0.87 [redacted]

I_n = 0.87 = circuit [redacted] ambient temp 40°C [redacted]

C_g [correction factor for grouping] [redacted]

small cable [redacted] circuit [redacted] = 1 circuits

circuit all cable [redacted] = [redacted] cables [redacted]

[redacted]

cable [redacted] cable [redacted] = cable [redacted]

[redacted] 0.393 [table 4B1 a]

C_a = 0.74 = [redacted] circuit [redacted]

C_i [correction factor for thermal insulation] [redacted]

cable [redacted] = [redacted] [thermal insulation] [redacted]

[redacted]

C_i = 1 [table 52.2, Appendix 4 (a)]

C_f [correction factor for (ground) current protective device] [redacted]

circuit [redacted] = mcb

[redacted]

C_g = 1 [table 52.2, Appendix 4 (a)]

[redacted]

$$I_b = \frac{50}{0.87 \times 0.74 \times 1 \times 1} = 100.8$$

I_b = 100.8A = required minimum current-carrying capacity

= circuit [redacted]

[redacted] cable [redacted] circuit [redacted] cable [redacted]

[redacted] 100.8A [redacted] Appendix 4 (a) current-carrying capacity cable [redacted]

circuit [redacted] cable [redacted] = 87°C rubber-insulated and non-armoured cable

cable [redacted] = multi-core

cable [redacted] = [redacted]

[redacted] Appendix 4 (a) [redacted] current-carrying capacity 135A [redacted]

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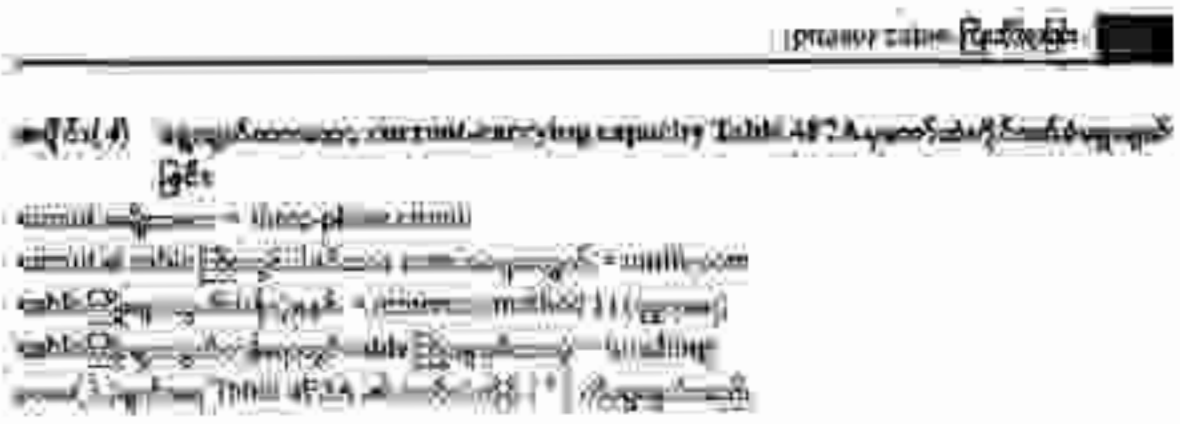

CIRCUITS IN ENCLOSED TRENCHES

Example 1-13

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[illegible]

[illegible]

[illegible]

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[redacted]

[redacted]

[redacted]

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[illegible] [illegible] Table 4B3 [illegible] [illegible]
[illegible] 35mm² [illegible]

[illegible] Table 4B3 [illegible] [illegible] [illegible]

$C_g = 0.69$

[illegible] [illegible] [illegible] [illegible]

$I_z \times C_g \times C_g \geq I$ [illegible]

I_n = 110A [illegible]
C_a = 0.80 [illegible]
C_g = 0.87 [illegible]
I_z = 85A [illegible]

[illegible]

110 × 0.87 × 0.69A ≥ 62A

66A ≥ 62A

[illegible] 66A [illegible] I_z [illegible] 85A [illegible] [illegible]

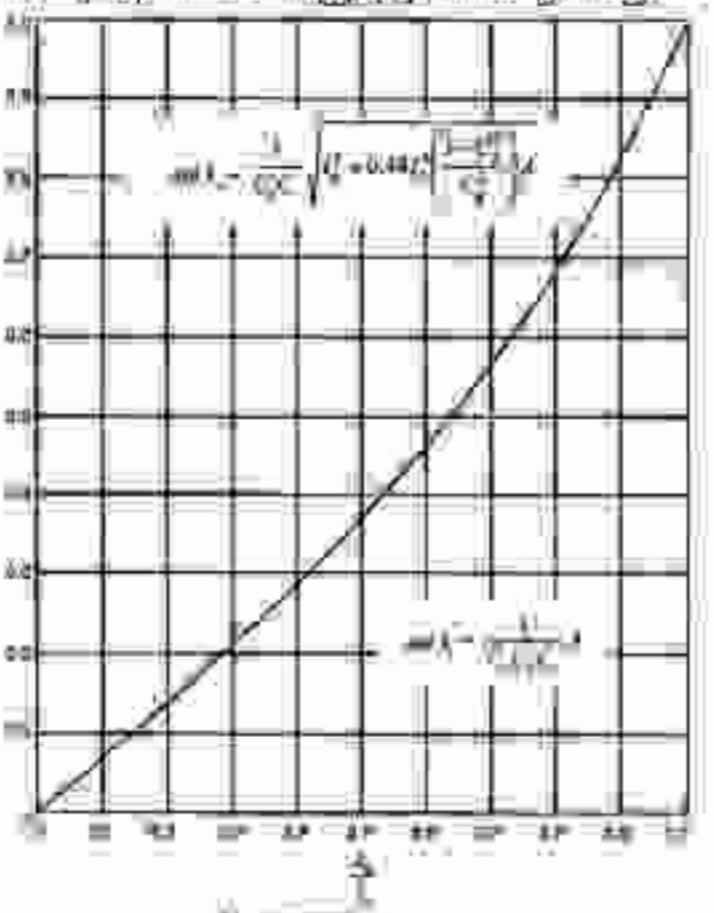

Figure 1 [illegible]

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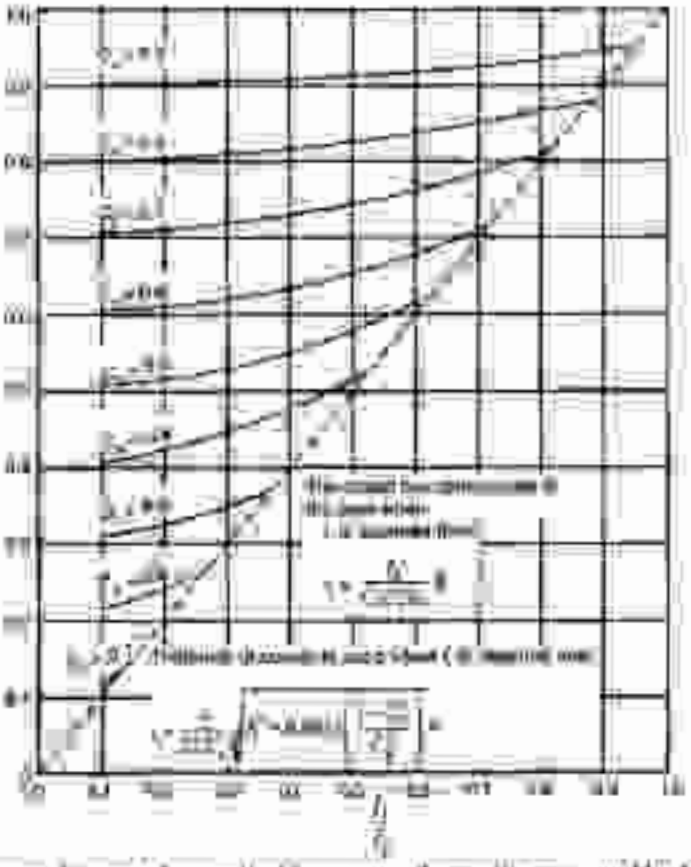

GROUPED CIRCUITS NOT LIABLE TO SIMULTANEOUS OVERLOAD

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[illegible]

ဥပမာ (1) circuit တစ်ခုတွင် BS 88 "gG" fuse ကို current rating [illegible] သုံးထားသည်။

ဆိုင်ရာ (2) design current I_b [illegible]

ဆိုင်ရာ (3) current [illegible]

ဆိုင်ရာ (4) C_a (correction factor for ambient temperature) [illegible]

ဆိုင်ရာ (5) C_g (correction factor for grouping) [illegible]

ဆိုင်ရာ (6) C_i (correction factor for thermal insulation) [illegible]

ဆိုင်ရာ (7) I_t (tabulated current carrying capacity) [illegible]

ဆိုင်ရာ (8) I_n (circuit [illegible]) [illegible]

ဆိုင်ရာ (9) [illegible] Appendix 4 [illegible]

ဆိုင်ရာ (10) [illegible]

ဆိုင်ရာ (11) [illegible]

ဆိုင်ရာ (1) circuit [illegible] BS 88 "gG" [illegible]

[illegible]

ဆိုင်ရာ (2) design current I_b [illegible]

[illegible]

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[redacted] $\frac{I}{I_n}$ = current ratio

I_n = 32A (rating of protective device)

I_a = 26A (rating of cable)

$\frac{I_a}{I_n} = \frac{26}{32} = 0.813$

[redacted] C_a (correction factor for ambient temperature) [redacted]

[redacted] cable [redacted] = 70°C pvc-insulated non-sheathed cable

ambient [redacted] = 45°C (given)

[redacted] = 65.88°C (nearest)

[redacted] (page 395 | Table 4C1)

C_a = 0.79 = [redacted]

[redacted] C_g (correction factor for grouping) [redacted]

[redacted] = 7 circuits

[redacted] = conduit [redacted] cable [redacted]

= reference method 3 (page 388 | Table 4A) [redacted]

[redacted] (page 393 | Table 4B1)

C_g = 0.54 = [redacted]

[redacted] C_i (correction factor for thermal insulation) [redacted]

[redacted] (thermal insulating material) [redacted]

[redacted] C_i = 1 (page 382 | Appendix 1)

[redacted] I_t (tabulated current-carrying capacity) [redacted] (page 41) | Figure 1.1)

$\frac{I_a}{I_t} = 0.813$ [redacted] C_a = 0.79 [redacted] C_g = 0.54 [redacted] Figure 1.1 [redacted]

Figure [redacted]

$I_t = \frac{I_n}{C_a C_g}$ [redacted]

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Example 1.15

Eight similar three-phase circuit ဖြာယူသည့်အခြေအနေတွင် cable ကြိုးများ 85°C rubber-insulated cable အချင်းပေါ်မူတည်၍ multi-core cable ကြိုးများတွင်သော်လည်းကောင်း cable များအတွင်း ဖြတ်သန်းသွားသော current ကြောင့် conductor temperature မြင့်တက်လာသည်။ cable ကြိုးများကို cable ပုံစံအလိုက် ခွဲခြားထားသော circuit arrangement များအတွက် current carrying capacity ဇယားများ ပြုစုထားသည်။ current ဖြာယူသည့် circuit တစ်ခုအတွက် ambient temperature = 30°C, design current I_b = 50°C, design current I_b = 34A တို့ကို သတ်မှတ်ထားသည်။

ဤဥပမာတွင် circuit များကို grouped circuit များအဖြစ် ခွဲခြားထားပြီး cable များကို multi-core cable များအဖြစ် ခွဲခြားထားသည်။

ပုံစံအလိုက် ခွဲခြားဖော်ပြထားသော cable များအတွက် current carrying capacity ဇယားများ ပြုစုထားသည်။

ဖြေရှင်းနည်း (1) circuit တွင် ဖြာယူသည့် cable ကြိုးများ၏ ambient temperature ကို သတ်မှတ်ရန်

ဖြေရှင်းနည်း (2) design current I_b ကို ရှာဖွေရန်

ဖြေရှင်းနည်း (3) $\frac{I_b}{I_n}$ current ဆက်ဆံရေးကို ရှာဖွေရန်

ဖြေရှင်းနည်း (4) C_a (correction factor for ambient temperature) ကို ရှာဖွေရန်

ဖြေရှင်းနည်း (5) C_g (correction factor for grouping) ကို ရှာဖွေရန်

ဖြေရှင်းနည်း (6) C_i (correction factor for thermal insulation) ကို ရှာဖွေရန်

ဖြေရှင်းနည်း (7) I_z (cable current-carrying capacity) ကို ရှာဖွေရန် သတ်မှတ်ချက်များ (4), (5) နှင့် Figure 1.1 ပုံစံတို့ကို အသုံးပြု၍ ရှာဖွေရန်

ဖြေရှင်းနည်း (8) I_n (circuit breaker သို့မဟုတ် cable ကြိုးများ၏ nominal current) ကို ရှာဖွေရန်

ဖြေရှင်းနည်း (9) cable ကြိုးများ၏ current carrying capacity ဇယားများမှ cable ကြိုးများ၏ ပုံစံအလိုက် Appendix 4 မှ current carrying capacity table များကို ရှာဖွေရန်

ဖြေရှင်းနည်း (10) ရွေးချယ်ထားသော current carrying capacity table မှတစ်ဆင့် cable ကြိုးများ၏ ဆိုင်းဘုတ်ကို ရှာဖွေရန်

ဖြေရှင်းနည်း (11) ရွေးချယ်ထားသော current carrying capacity table မှ cable ကြိုးများ၏ I_z တန်ဖိုးများကို ဆိုင်းဘုတ် I_n တန်ဖိုးများနှင့် နှိုင်းယှဉ်ခြင်းဖြင့် circuit များရှိ cable ကြိုးများသည် overload ဖြစ်ခြင်း၊ မဖြစ်ခြင်းတို့ကို ဆုံးဖြတ်ရန်

ဖြေရှင်းနည်း (1) circuit တွင် ဖြာယူသည့် cable များ၏ ambient temperature ကို သတ်မှတ်ရန်

ambient temperature = 30°C, protective device ကို ကာကွယ်ထားသော cable များ၏ I_n = 40A, cable များ၏ I_z = 40A

ဖြေရှင်းနည်း (2) design current I_b ကို ရှာဖွေရန်

I_b = 34A (ပုစ္ဆာတွင်ပေးထားသည်)

ဖြေရှင်းနည်း (3) $\frac{I_b}{I_n}$ current ဆက်ဆံရေးကို ရှာဖွေရန်

I_n = 40A (ဖြေရှင်းနည်း (1) တွင်ရှာဖွေခဲ့ပြီး)

I_b = 34A (ဖြေရှင်းနည်း (2) တွင်ရှာဖွေခဲ့ပြီး)

$$\frac{I_b}{I_n} = \frac{34}{40} = 0.85$$

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Table 1.2 Correction factors for low ambient temperature

Type of cable insulation	Protection of overcurrent protective device	Ambient temperature (°C)					
		0	5	10	15	20	25
70°C pvc	With fuse will or without short circuit protection	1.14	1.14	1.12	1.07	1.00	1.07
	Short circuit protection only	1.33	1.28	1.22	1.15	1.12	1.06
85°C rubber	Overload, with or without short circuit protection	1.11	1.10	1.07	1.05	1.04	1.02
	Short circuit protection only	1.24	1.21	1.17	1.12	1.08	1.04
XLPE (105°C thermosetting)	Overload with or without short circuit protection	1.11	1.09	1.07	1.05	1.04	1.02
	Short circuit protection only	1.22	1.19	1.15	1.12	1.08	1.04

CIRCUITS IN LOW AMBIENT TEMPERATURE

[redacted]

Example 1.16

[redacted]

[redacted]

ဖြေရှင်းချက်တွင် အဆိုပါအချက်များကို ဖြည့်စွက်ပါသည်။

အဆင့်(1) [redacted] protection type [redacted]

အဆင့်(2) [redacted]

အဆင့်(3) [redacted] BS7671 [redacted] current-carrying capacity table [redacted]

အဆင့်(4) [redacted] current-carrying capacity table [redacted]

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[illegible]

[illegible]

[illegible]

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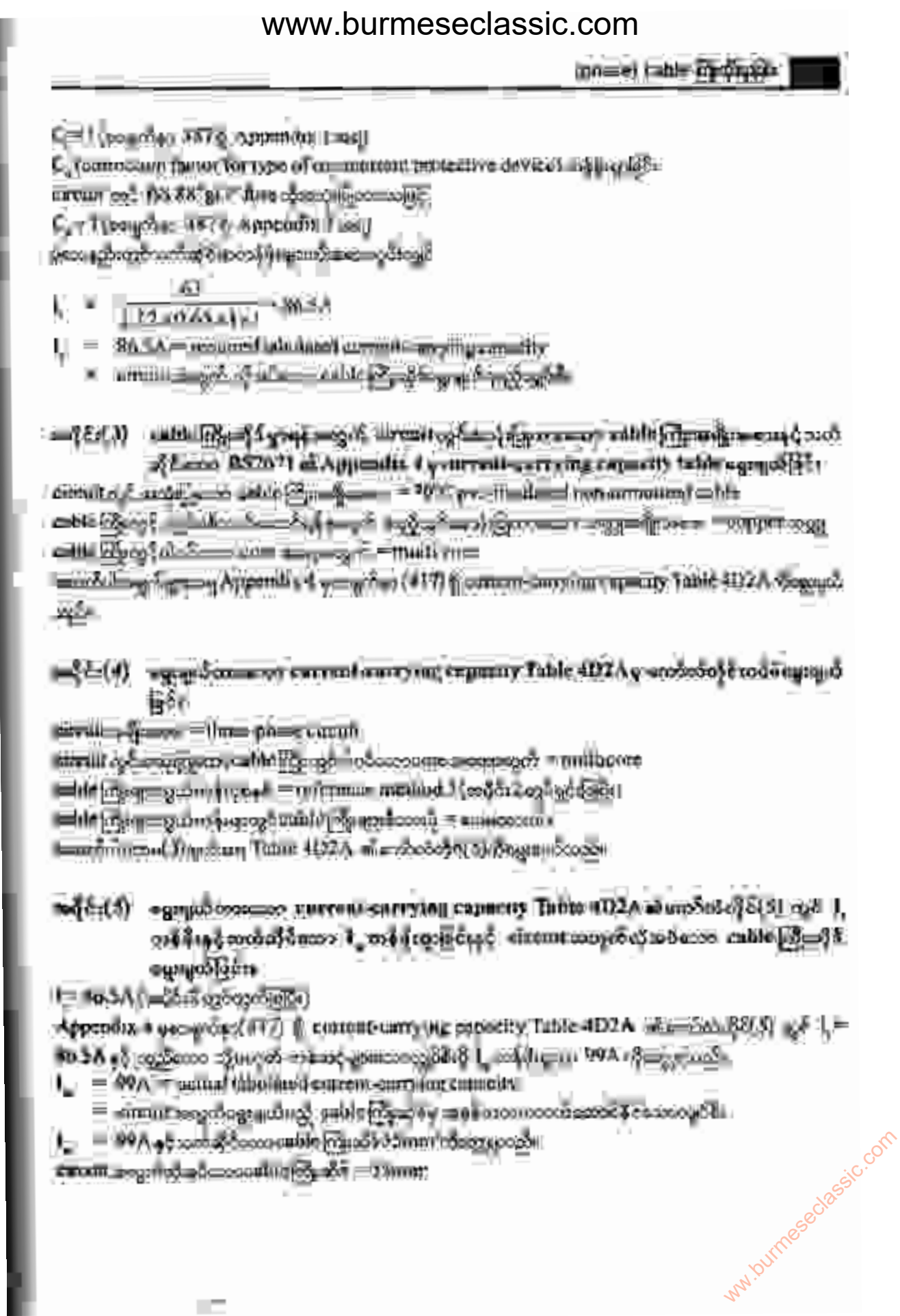

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MOTOR CIRCUITS SUBJECT TO FREQUENT STOPPING AND STARTING

[redacted]

[redacted]

(1) [redacted]

(2) [redacted]

(3) [redacted]

Example 1.47

[redacted]

ဆုံးဖြတ်ချက် (1) [redacted]

ဆုံးဖြတ်ချက် (2) [redacted]

ဆုံးဖြတ်ချက် (3) [redacted]

ဆုံးဖြတ်ချက် (4) [redacted]

ဆုံးဖြတ်ချက် (5) [redacted]

ဆုံးဖြတ်ချက် (6) [redacted]

ဖြေရှင်းချက် (1) [redacted]

$$\text{power} = 10\text{hp} \times 746\text{W}$$

$$= 7460\text{W}$$

[redacted]

$$= \frac{7460}{240} = 31.1\text{A}$$

[redacted]

ဆုံးဖြတ်ချက် (2) [redacted]

[redacted]

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[illegible] Appendix 4.A [illegible] Table 4F2.A [illegible]

[illegible] current-carrying capacity Table 4F2.A [illegible]

circuit [illegible] = single-phase circuit

circuit [illegible] cable [illegible] = multi-core

cable [illegible] = clipped direct

= reference method [illegible] Table 4A [illegible]

cable [illegible] = [illegible]

[illegible] Table 4F2.A [illegible] (4) [illegible]

[illegible] current-carrying capacity Table 4F2.A [illegible] (4) [illegible] circuit [illegible] cable [illegible]

I_t = 55 A (multi-core)

[illegible] 434 [illegible] Table 4F2.A [illegible] I_t [illegible]

I_n = 45 A [illegible]

I_n = 45 A [illegible]

[illegible] circuit [illegible]

Example 4.28

[illegible] three-phase motor [illegible] 15 kW power factor 0.8 [illegible]

[illegible] circuit [illegible] cable [illegible]

[illegible] 70°C pvc-insulated and sheathed cable [illegible] multicore cable [illegible]

[illegible] ambient temperature [illegible] I_t = 30°C [illegible] cable [illegible]

[illegible] reference method B [illegible]

circuit [illegible] Table [illegible]

[illegible]

[illegible] design current [illegible] full load current

[illegible] cable [illegible] design current [illegible] I_t

(ambient temperature [illegible])

[illegible] I_t (circuit [illegible] cable [illegible])

[illegible] cable [illegible] circuit [illegible] cable [illegible]

[illegible] Appendix 4 [illegible] current-carrying capacity table [illegible]

[illegible] current-carrying capacity table [illegible]

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ဥပမာ(၁) ချမှတ်ထားသော current-carrying capacity table မှ ကြိုးတန်ဖိုး ရှာဖွေနည်း၊ ဝန်ထုပ်ဝန်ပိုး ဖြစ်ပေါ်စေသော circuit အတွက် cable ကြိုးအရွယ်အစား

ဥပမာ(၂) စက်တစ်လုံး design current တန်ဖိုးသည် full load current ဖြစ်သည်။

power = 15kW / 11,000W
voltage = 415V
circuit = three-phase circuit
efficiency = 80%

design current (I) for full load current = $\frac{15{,}000}{\sqrt{3} \times 415 \times 0.8 \times 0.9}$ = 29A (per phase)

design current = 29A per phase

ဥပမာ(၃) cable ကြိုးတစ်ခုတွင် design current ကို အပြည့်အဝ ပို့ဆောင်ပေးနိုင်ရန်

I_t = design current × 1.4 (ဘေးအန္တရာယ်အချိုး)

design current = 29A per phase ဖြစ်ရာ 1 ဖေ့စ်အတွက်

I_t = 29 × 1.4 = 40.6A

= circuit အတွက် ချမှတ်ထားသော cable ကြိုးအရွယ်အစားသည် ကြိုးတန်ဖိုး (current carrying capacity) 40.6A ရှိရမည်

ဥပမာ(၄) I_t (current carrying capacity) cable ကြိုးအရွယ်အစားကို ရှာဖွေနည်း (ဇယား Appendix VI)

$I_t = \frac{I_n}{C_a \times C_g \times C_i}$

I_n = 40.6A (ဥပမာ 2 မှ ရရှိသော)

C_a (correction factor for ambient temperature) ကိုရှာဖွေခြင်း

circuit အတွက် ကြိုးအရွယ်အစား 7/0.67 PVC insulated and sheathed cable

ဤကြိုးအတွက် I_t = 52A

ဤကြိုးသည် protective device မှ 95.0m ဝေးသော ... ရှိ protective device မှ ကာကွယ်ပေးရမည်

ဇယား (3) Table VI မှ

C_a = 0.94 ... ဖြစ်ပါသည်။

C_g (correction factor for grouping) ကိုရှာဖွေခြင်း

ဤကြိုးသည် ... ဖြစ်ရာ

C_g = 1 (ဇယား 3B7 မှ Appendix I အရ)

C_i (correction factor for thermal insulation) ကိုရှာဖွေခြင်း

cable ကြိုးများ ... ဖြစ်ရာ

C_i = 1 (ဇယား 3B7 မှ Appendix I အရ)

C_a (correction factor for type of overcurrent protective device) ကိုရှာဖွေခြင်း

circuit ... ဖြစ်ရာ

ဖြစ်သည်။

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[redacted]

$$I_b = \frac{400}{0.94} = 19.2\text{A}$$

[redacted]

ဥပမာ(4) [redacted] BS7671 ၏ Appendix 4 မှ current-carrying capacity table များဖြင့် ရှာပုံ

[redacted]

ဖြေရှင်း(5) [redacted]

[redacted]

ဥပမာ(6) [redacted]

[redacted]

CIRCUITS FOR STAR-DELTA STARTING OF MOTORS

[redacted]

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Example 1.19

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[illegible]

$$\text{Line current} = \frac{\text{Power}}{\sqrt{3} \times \text{Line voltage} \times \text{Power factor}}$$

$$= \frac{20{,}000}{\sqrt{3} \times 0.85 \times 0.9} = 35.0\text{A}$$

[illegible] line current [illegible]

line current = design current = 35.0A [illegible]

[illegible]

I = 35.0A [illegible]

[illegible]

[illegible]

$$I = \frac{U}{C_1 C_2 C_3 C_4} \quad \text{[illegible]}$$

I_t = 35.0A [illegible]

C_1 [illegible]

C_2 = 0.70 [illegible]

C_3 = 0.80 [illegible]

C_4 = 1.0 [illegible]

C_5 [illegible]

C_6 = 1.0 [illegible]

C_7 [illegible]

C_8 = 1.0 [illegible]

C_9 [illegible]

C_{10} = 1.0 [illegible]

$$I = \frac{35.0}{0.8 \times 1.0 \times 1.0} = 35.0\text{A}$$

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CHANGE OF PARAMETERS OF ALREADY INSTALLED CIRCUITS

[illegible]

[illegible]

[illegible]

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I_t = actual tabulated current-carrying capacity
= [illegible] cable [illegible]
C_a = correction factor for ambient temperature
C_g = [illegible] factor for grouping
C_i = [illegible] factor for thermal insulation

Example 4-39

[illegible] three-phase circuit [illegible] cable [illegible] "clipped direct" [illegible] PVC-insulated and non-armoured cable [illegible] multicore cable [illegible] [illegible] copper conductor [illegible] [illegible] 3 circuits [illegible] cable [illegible] [illegible] cable [illegible] [illegible] circuit [illegible] cable [illegible] [illegible] circuit [illegible] [illegible] I_t = 50°C [illegible]

[illegible] BS 88 "G" fuse [illegible] [illegible] BS 88 "G" fuse [illegible] [illegible]

[illegible] $I = I_t \times C \times C_a \times C_g \times C_i$ [illegible]

[illegible]

$I_t = I_n \times C_a \times C_g \times C_i$ [illegible] I_t [illegible] I_n [illegible]

[illegible]

အပိုင်း(1) [illegible] circuit [illegible] cable [illegible] BS7671 ရဲ့ Appendix 4 ရဲ့ current-carrying capacity table [illegible]

အပိုင်း(2) [illegible] current-carrying capacity table [illegible]

အပိုင်း(3) [illegible] current-carrying capacity table ရဲ့ [illegible] cable [illegible] I_n [illegible]

အပိုင်း(4) C_a (correction factor for ambient temperature) [illegible]

အပိုင်း(5) C_g (correction factor for grouping) [illegible]

အပိုင်း(6) C_i (correction factor for thermal insulation) [illegible]

အပိုင်း(7) [illegible] I_t (conductor tabulated current-carrying capacity) [illegible]

အပိုင်း(8) circuit [illegible] BS 88 "G" [illegible]

အပိုင်း(9) design current I_n [illegible]

အပိုင်း(1) [illegible] cable [illegible] I_t [illegible] BS7671 ရဲ့ Appendix 4 ရဲ့ current-carrying capacity table [illegible]

[illegible]

[illegible]

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[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

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I_n = 80A (...)
C_a = 0.71 (...)
C_g = 0.87 (...)
C_s = 1 (...)
...
I_z = 80 × 0.71 × 0.87 × 1 = 52.4A
I_z = 52.4A = corrected current-carrying capacity
= circuit ... cable ...

... circuit ... BS88"pG" ... $I_n < I_z$ ...
I_z = 52.4A (...)
...
I_n = 40A (), I_z = 52.4A ()
I_n = 40A current ... BS 88"pG" ...

... design current I_b ...
... $I_n < I_z < I_b$ ...
design current I_b = I_n = 40A (BS 88"pG" ...)

Example 1-21

... three-phase circuit ... cable ... conduit ... cable ... multi-core cable ... cable ... circuit ... cable ... 25mm² ... circuit ... I_n = 100A ... circuit ... HBC ... design current I_b ... HBC ...

circuit ... then-circuit ... HBC ...

$I_z = I_t \times C_a \times C_g \times C_s$ A ... C_s = 1 ... C_a ... circuit ... HBC ... $I_n \geq I_b$ ...

...

... : ... cable ... I_t ... circuit ... cable ... BS 88"pG" ... Appendix 4 ... current-carrying capacity Table ...

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[illegible] C_g [illegible]

[illegible]

[illegible] C_t [illegible]

[illegible]

[illegible] I_z [illegible]

[illegible]

[illegible]

[

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[illegible]

[illegible]

[illegible] Table 405 [illegible]

[illegible] Table 405 [illegible]

[illegible] C_a (correction factor for ambient temperature) [illegible]

[illegible] C_c (correction factor for grouping) [illegible]

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[redacted]

[redacted]

[redacted]

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[redacted]

Conductor maximum normal operating temperature	Maximum permitted burning temperature of the group			
	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	1			
[redacted]	0.87	1		
[redacted]	0.94	1.08	1	
[redacted]	0.91	1.05	0.98	1

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CHAPTER - 2

Calculation of Voltage Drop Under Normal Load Condition

(Circuit တွင် ပုံမှန်အားဖြင့် voltage drop တွက်ချက်ခြင်း)

Chapter ၂ အကျဉ်း ချုပ်ခြင်း

ပြီးခဲ့သော chapter တွင် voltage drop သည် ဘာကြောင့် ဖြစ်ပေါ်လာသည်ကို ဆွေးနွေးခဲ့ပြီးဖြစ်ပါသည်။ ထို့အတူ voltage drop ကို

(၁) ဘယ်လို နည်းလမ်းများဖြင့် တွက်ချက်ရမည်

(၂) ဘယ်လို နည်းလမ်းများဖြင့် လျှော့ချနိုင်သလဲ

စသည်တို့ကိုလည်း ဆွေးနွေးခဲ့ပြီးဖြစ်ပါသည်။ ဒီ chapter မှာတော့ ပုံမှန် load condition အောက်မှာ circuit တစ်ခုရဲ့ voltage drop ကို ဘယ်လို တွက်ချက်ရမလဲဆိုတာကို ဆွေးနွေးသွားမှာ ဖြစ်ပါတယ်။ ဒီလို တွက်ချက်ရာမှာ table ကို အသုံးပြုပြီး ဘယ်လို တွက်ချက်ရမလဲဆိုတာကိုလည်း ဆွေးနွေးသွားမှာ ဖြစ်ပါတယ်။ ထို့အပြင် table ကို အသုံးပြုပြီး တွက်ချက်ရာမှာ ဘယ်လို အချက်အလက်များကို သိရှိဖို့ လိုအပ်သလဲဆိုတာကိုလည်း ဆွေးနွေးသွားမှာ ဖြစ်ပါတယ်။

voltage drop တွက်ချက်ရာတွင် သက်ဆိုင်သော အချက်အလက်များသည် (၅)ခုရှိပါသည်။ အဓိကအားဖြင့် load power factor ကို ကောင်းအောင် ပြုပြင်ခြင်းဖြင့် circuit တစ်ခုရဲ့ voltage drop ကို ဘယ်လောက် လျှော့ချနိုင်သလဲဆိုတာကိုလည်း ဆွေးနွေးသွားမှာ ဖြစ်ပါတယ်။

Voltage drop ကို တွက်ချက်ရာတွင် လိုအပ်သော အချက်အလက်များ

(၁) Type of cable

(cable အမျိုးအစား)

(၂) The maximum current

(circuit တွင် စီးဆင်းသော အများဆုံး လျှပ်စီးကြောင်း)

(၃) The permissible voltage drop

(ခွင့်ပြုနိုင်သော အများဆုံး voltage drop)

(၄) The circuit length

(circuit အလျား)

(၅) The type of circuit (d.c. circuit, single-phase a.c. circuit, three-phase a.c. circuit)

(၆) The load current

(circuit တွင် ဖြစ်ပေါ်နေသော load current)

ဆောင်ရွက်ရမည် voltage drop တွက်ချက်မှုတွင် ဝတ္ထုအားလုံးတွင် အရေးပါဆုံးမှာ ဖြစ်ပါသည်။

voltage drop တွက်ချက်ခြင်း ဥပဒေများနှင့် cable ကြိုးဆိုင်ခေါ် နှစ်သည်ကို အခြေခံ၍ (၂) ခုခြင်း သတ်မှတ်ချိန်း၊ voltage drop တွက်ချက်ရာ အတွင် အသုံးပြုသော cable ကြိုးအရှိန်ကို (၂) ခုခြင်း ခွဲခြားသတ်မှတ်ခြင်း၊ အလွှာများကို ကြိုးဆိုင်ခြင်းအတွက်ကိုလည်း ထည့်သွင်းစဉ်းစားသွားမည် ဖြစ်ပါသည်။

အသုံးပြုသော cable ကြိုးကို ပုံမှန် load ရှိ ဖြတ်သန်းသွားသော (amps)

အသုံးပြုသော cable ကြိုးကို ဘယ်လောက် ရှည်သော (volts)

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[redacted]

[redacted]

[redacted]

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Example 2.2

[illegible]

[illegible]

ဖြေရှင်း (1) voltage drop ရှာရန် BS7671 ၏ Appendix 4 မှ mV/A/m တန်ဖိုး ယူရန် လိုအပ်ပါသည်။ ထို့ကြောင့် table ကြီးမှ ကြိုးအမျိုးအစားနှင့် ကိုက်ညီသော voltage drop table ကို ရွေးချယ်ရပါမည်။

ဖြေရှင်း (2) ရွေးချယ်ထားသော voltage drop table ၏ တစ်ပေါက်နှုန်း တစ်ခြမ်းအားဖြင့်ပြပါ။

ဖြေရှင်း (3) ကမ္ဘာမြေ ကွင်းဆက်ပြတ်တောက်မှု ရှာဖွေတွက်ချက်ရာတွင် သင်အသုံးပြုသော voltage drop တန်ဖိုးများ ဖော်ပြပါ။

ဖြေရှင်း (4) ရွေးချယ်ထားသော voltage drop table တစ်ခုတွင် similar voltage drop တန်ဖိုးများ ရှာဖွေပါ။

ဖြေရှင်း (5) single phase circuit တွင် phase to neutral voltage drop ရှာဖွေပါ။

ဖြေရှင်း (1) voltage drop များကို BS7671 ၏ Appendix 4 မှ mV/A/m တန်ဖိုးများ ယူရန် လိုအပ်ပါသည်။ ထို့ကြောင့် table ကြီးမှ ကြိုးအမျိုးအစားနှင့် သက်ဆိုင်သော voltage drop table များကို ရွေးချယ်ရပါမည်။

[illegible]

[illegible]

ဖြေရှင်း (2) ရွေးချယ်ထားသော voltage drop Table 4D2B မှ တစ်ပေါက်နှုန်း တစ်ခြမ်းအားဖြင့်ပြပါ။

[illegible]

[illegible]

ဖြေရှင်း (3) Circuit တွင် တည်ဆောက်ထားသော earth ကြိုးအရှည်နှင့် ရွေးချယ်ထားသော terminated mv/A/m တန်ဖိုးများအတိုင်း တွက်ချက်ပါ။

[illegible]

[illegible]

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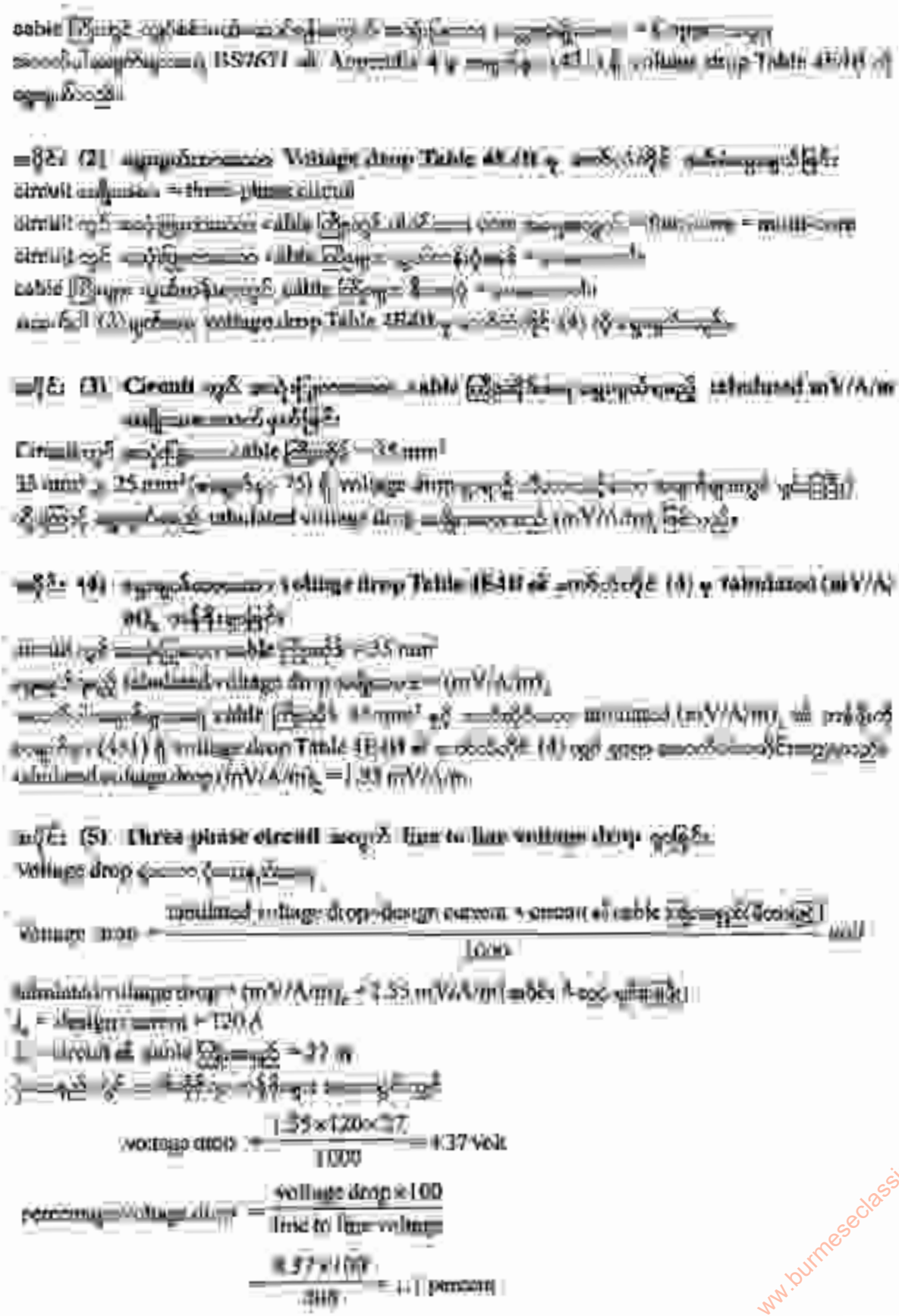

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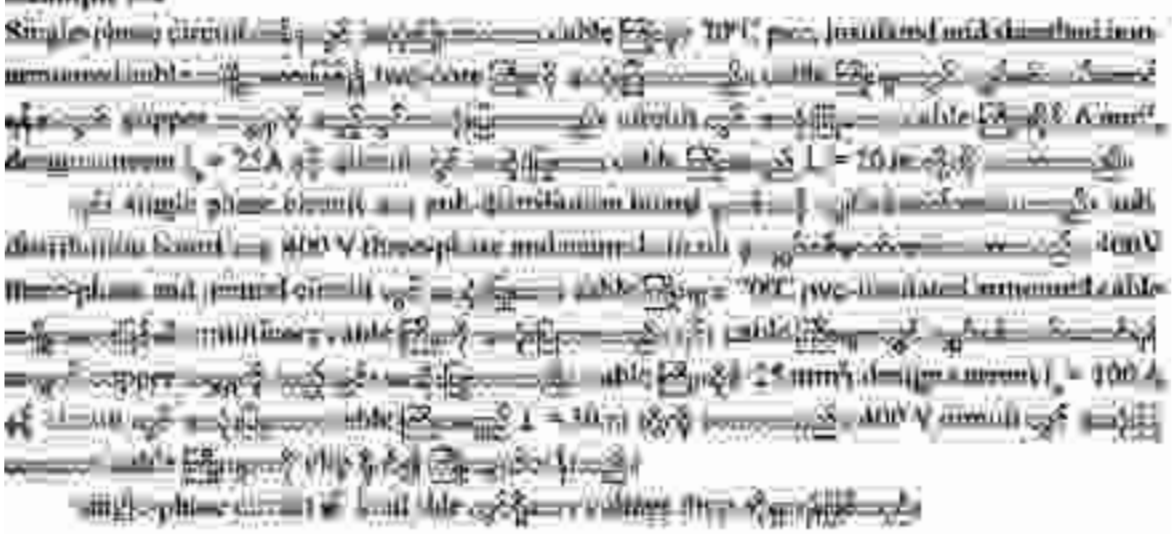
Example 2-4



single-phase circuit ၏ final ဖြစ်သော voltage drop ကို ရှာဖို့လျှောက် (၂) ခိုင်ခြင်း ဖြေရှင်းပါ။

(A) 400V three-phase unit neutral circuit မှ ချိတ်ဆက်ထားသော sub-distribution board ရှိရာသော voltage drop ရှာခြင်း

(B) sub-distribution board မှတစ်ဆင့် လှုပ်ရှားမှုကြောင့်သော single-phase circuit ၏ final ဖြစ်သော voltage drop ရှာခြင်းတို့ဖြစ်ပါသည်။

(A) 400 V three-phase and neutral circuit မှ ချိတ်ဆက်ထားသော sub-distribution board ရှိရာသော voltage drop ရှာခြင်း

ဖော်ထုတ်ရမည့်အချက်များ ရှာဖွေဖြေရှင်းခြင်း

အဆင့်(A-1) Voltage drop ရှာဖွေရန်အတွက် BS 7671 ၏ Appendix 4 ရှိ circuit တွင် အသုံးပြုထားသော cable အမျိုးအစားနှင့် ထားရှိပုံအား voltage drop table များကိုကြည့်ရှုခြင်း

အဆင့်(A-2) များပြားသော voltage drop table ၌ တစ်ခုချင်းစီ ဆက်လက်ရှာဖွေခြင်း

အဆင့်(A-3) Circuit တွင် အသုံးပြုထားသော table အမျိုးအစားနှင့် ရောက်ရှိလာသည့် tabulated voltage drop အချိုးအစားတို့ကိုတွက်ချက်ခြင်း

အဆင့်(A-4) များပြားသော voltage drop table ၏ အတိအလင်းဖြစ်သော tabulated voltage drop အနိမ့်ဆုံးများကိုရှာခြင်း

အဆင့်(A-5) 400 V three-phase circuit အတွက် line to line voltage drop ရှာခြင်း

အဆင့်(A-6) sub-distribution board ရှိရာသော line to line and line to neutral voltage များရှာခြင်း

အဆင့်(A-1) voltage drop ရှာဖွေရန်အတွက် BS7671 ၏ Appendix 4 ရှိ circuit တွင် အသုံးပြုထားသော cable အမျိုးအစားနှင့် ထားရှိပုံအား voltage drop table များကိုကြည့်ရှုခြင်း

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I_n = normal load current carrying current

I_z = maximum permitted normal operating conductor temperature °C

t_a = reference ambient temperature °C

$$\frac{\text{design mV/A/m}}{\text{tabulated mV/A/m}} = \frac{230+t_c}{230+t_a}$$

above equation is based on the approximate value of resistance temperature coefficient 0.004 per °C at 20°C which is applicable to both copper and aluminium conductor.

(i) $\text{design mV/A/m} = \frac{230+t_c}{230+t_a} \times \text{tabulated mV/A/m}$

(ii) t_c°C အပူချိန်တွင် Voltage drop = $\left[\frac{230+t_c}{230+t_a}\right] \left[\frac{\text{tabulated mV/A/m} \times I_n \times L(\text{metres})}{1000}\right]$ volt

Example 2

Single-phase circuit တစ်ခုတွင် အသုံးပြုထားသော cable မှာ 70°C pvc-insulated and armoured cable ဖြစ်ပြီး two-core cable ဖြစ်သည်။ cable ကြိုးတွင် သွားရောက်ပြန်လာသော copper လျှပ်စီးဆုံးရှုံးမှုကိုလည်း တွက်ချက်ရန် circuit ဖြစ်သည်။ cable ကြိုးသည် 16 mm² design current I_n = 70 A circuit ၏ တစ်ဖက်မှ အဆုံးမှ 35°C ရှိ circuit ဘက်ရောက်သော cable ကြိုးအရှည် L = 30 m ဖြစ်သည်။ circuit တစ်လျှောက် ဖောက်ထုတ်ထားသော cable ကြိုးများ၏ phase to neutral voltage drop ကို ရှာဖွေပြရန် ဖြစ်သည်။

ပုဂ္ဂလိကပိုင်ဆိုင်သော အဆောက်အအုံများတွင် ဆိုလိုတာရပ်ကွက်ပြုလုပ်ရေးနှင့် ပတ်သက်သည်ဖြစ်သည်။

(i) circuit အသစ်ထပ်ဆောင်းခြင်း cable ကြိုးများ အပြောင်းအလဲများပြုလုပ်ခြင်းများ ရှိသည်။

$$I_z = I_n \times \frac{t_1}{t_2} \quad (t_1 - t_2)^{\circ}C$$

(ii) circuit တစ်ခုတစ်ခုတွင် cable ကြိုးများ ချိတ်ဆက်ထားခြင်းများ ရှိသည်။ voltage drop ရှာဖွေခြင်း

$$\text{voltage drop} = \frac{230+t_c}{230+t_a}\left[\frac{\text{tabulated mV/A/m} \times I_n \times \text{Length(metres)}}{1000}\right] \text{volt}$$

ထူးခြားချက် (၂) ချိုးနှိုင်း ဆောင်ရွက်ခြင်း ကွာခြားချက်

(A) Circuit တစ်လျှောက်တွင် cable ကြိုးများ အမျိုးအစားတူညီခြင်းများ ရှိသည်။

(B) Circuit တစ်လျှောက်တွင် cable ကြိုးများ ဆောင်ရွက်ခြင်းများ ရှိသည်။ ဖြစ်သော voltage drop ရှာဖွေခြင်း

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(A) Circuit [illegible] Table [illegible]

[illegible]

(B) [illegible]

[illegible]

(C) [illegible]

[illegible]

(D) [illegible]

[illegible]

(A) [illegible]

[illegible]

[illegible]

[

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ဇယား 18-3 မှတ်ချက်များအား Voltage drop Table 4D2B မှ ဆောင်ထိုင် အတိုးချဲ့ကြည့်ပါ။
Circuit အမျိုးအစား = Single-phase circuit
ကြိုးအမျိုးအစား = cable ကြိုးတွင် E သံပြားကာ ကော်ပတ်ကြိုး = two-core
ကြိုးတွင် အသုံးပြုထားသော cable ကြိုး၏ သွယ်ဝိုက်ပုံစံ = armoured
ဆက်လက် (2) ပုဒ်အား voltage drop Table 4D4B မှ ဆောင်ရွက်ပါ။ (3) ကို ဖော်ပြပါ။

ဥပမာ (18-3) ဥပမာတွင်ပါသော voltage drop table နှင့် ဂဏန်း ဆောင်ထိုင်ခြင်းနှင့် circuit တွင် အသုံးပြုထားသော cable ကြိုးအရှည်နှင့်အတိုင်းအား tabulated mV/A/m တန်ဖိုးရှာခြင်း

Circuit တွင် အသုံးပြုထားသော cable ကြိုးအရွယ် = 16 mm² (16mm² BS 767 ဖြတ်ကြိုးအတွက်)
circuit တွင် အသုံးပြုထားသော cable ကြိုးအရှည် 10 mm နှင့် အတိုင်းအား tabulated mV/A/m တန်ဖိုးကို BS7671 ၏ Appendix 4 ပုံစံများ (422) ရှိ voltage drop Table 4D4B မှ ဆောင်ရွက်ပြီး (1) မှတ်ချက် 2.8 mV/A/m ကို ရယူသည်။

tabulated mV/A/m = 2.8 mV/A/m

ဥပမာ (18-4) Circuit အလုပ်လုပ်နေစဉ် cable ကြိုးများတွင် အပူချိန်အမြင့်ဆုံးဖြစ်စေသော အလုပ်ကို ပို့ပြီးသော voltage drop အား ရှာဖွေသည့်အခါ ကွဲထွက်ပုံကိုဖြင့်

ဖြေရှင်းချက်

$$\text{voltage drop} = \left(\frac{230 + t_1}{230 + t_2}\right)\left[\frac{\text{tabulated mV/A/m} \times 1.6 \times \text{circuit length (metres)}}{1000}\right] \text{volts}$$

t_1 = 35°C = circuit အလုပ်လုပ်နေစဉ် cable ကြိုးများတွင် အပူချိန်အမြင့်ဆုံးဖြစ်စေသော အလုပ်ကို ပို့ပြီးသော အပူချိန် (ဇယား 4-1 ရှိ တွက်ချက်ပြုပြင်)

t_2 = 70°C = pre-unstalled and armoured cable အတွက် သတ်မှတ်ထားသော အများဆုံး အလုပ်လုပ်နိုင်သော အပူချိန် (ဇယား 4-1 ရှိ ရယူပါ)

tabulated mV/A/m = 2.8 mV/A/m (ဇယား 18-3) ၌ ဖော်ပြပါ)

I_b = 70 A = design current (ရွေးချယ် သတ်မှတ်ထားသော)

L = 30 m = circuit တွင် အသုံးပြုထားသော cable ကြိုးအရှည် (ပုံတွင်)

ပုံသေနည်းတွင် သတ်မှတ်ထားသော တန်ဖိုးများ အစားထိုးပြီး

$$\text{voltage drop} = \left(\frac{230 + 35}{230 + 70}\right)\left(\frac{2.8 \times 70 \times 30}{1000}\right) = 5.7 \text{ volts, phase to neutral voltage drop}$$

voltage drop = 5.7 volts = circuit အလုပ်လုပ်နေစဉ် cable ကြိုးများတွင် အပူချိန်အမြင့်ဆုံးဖြစ်စေသော အလုပ်ကို ပို့ပြီးသော 69.7°C ရှိ voltage drop

Example 5-6

Three-phase circuit complete အလုပ်လုပ်နေစဉ် cable ကြိုးများတွင် အပူချိန်အမြင့်ဆုံးဖြစ်စေသော အလုပ်ကို ပို့ပြီးသော multi-core cable ကြိုးကို အသုံးပြုထားသည်။ cable ကြိုးများ ဖွဲ့စည်းထားသော အတွင်း conductor အသုံးပြုထားသော cable ကြိုးအရွယ်သည် 16mm² ဖြစ်သည်။

အဆိုပါ current ကြောင့် cable ကြိုးများတွင် ဖော်ထုတ်ထားသော ambient method 13 (ဇယား 4B1) ambient method 13 အတွက် အသုံးပြုထားသော ကြိုးသယ်ဆောင်နိုင်စွမ်းရည်ကို ရှာဖွေပါ။

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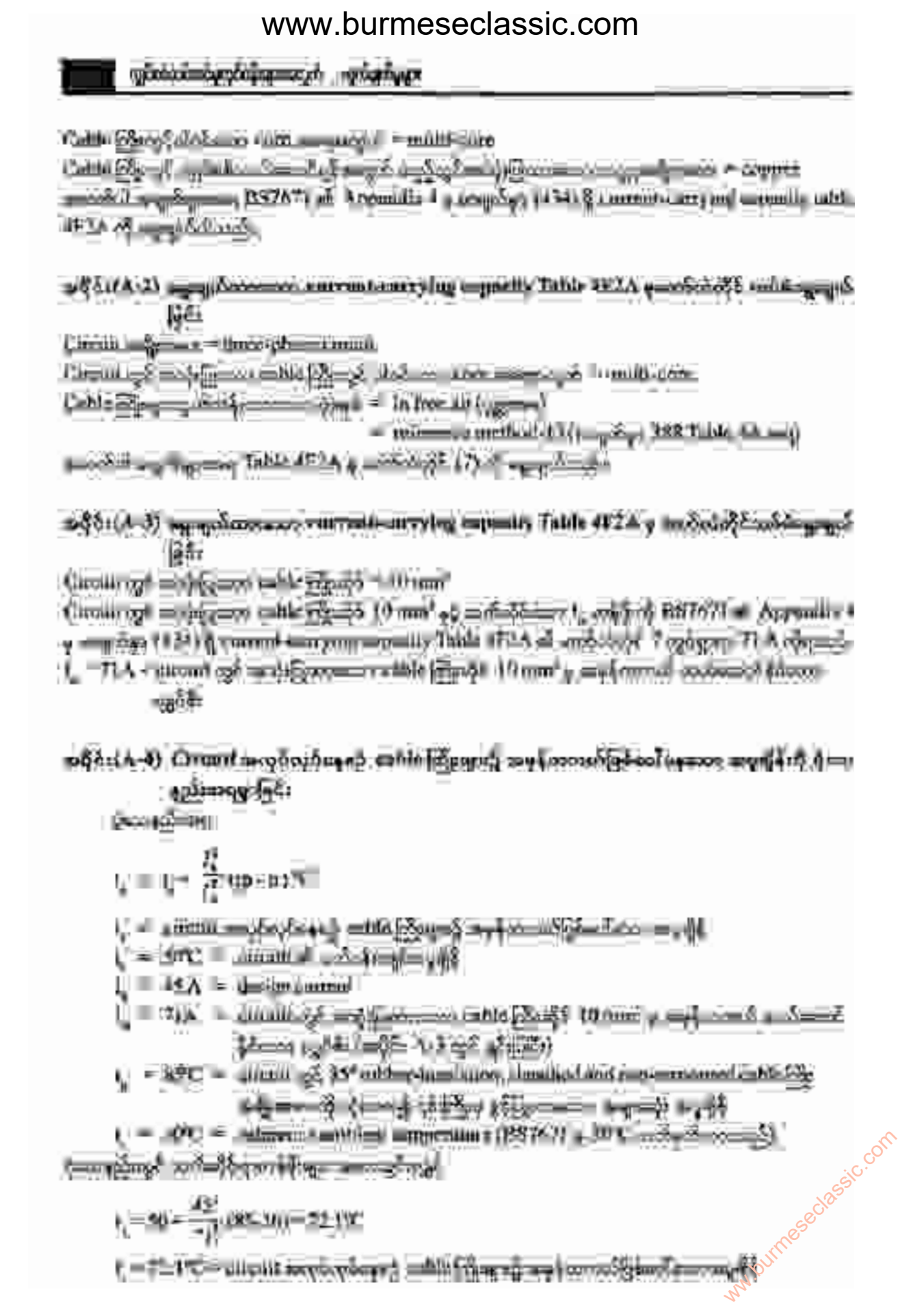

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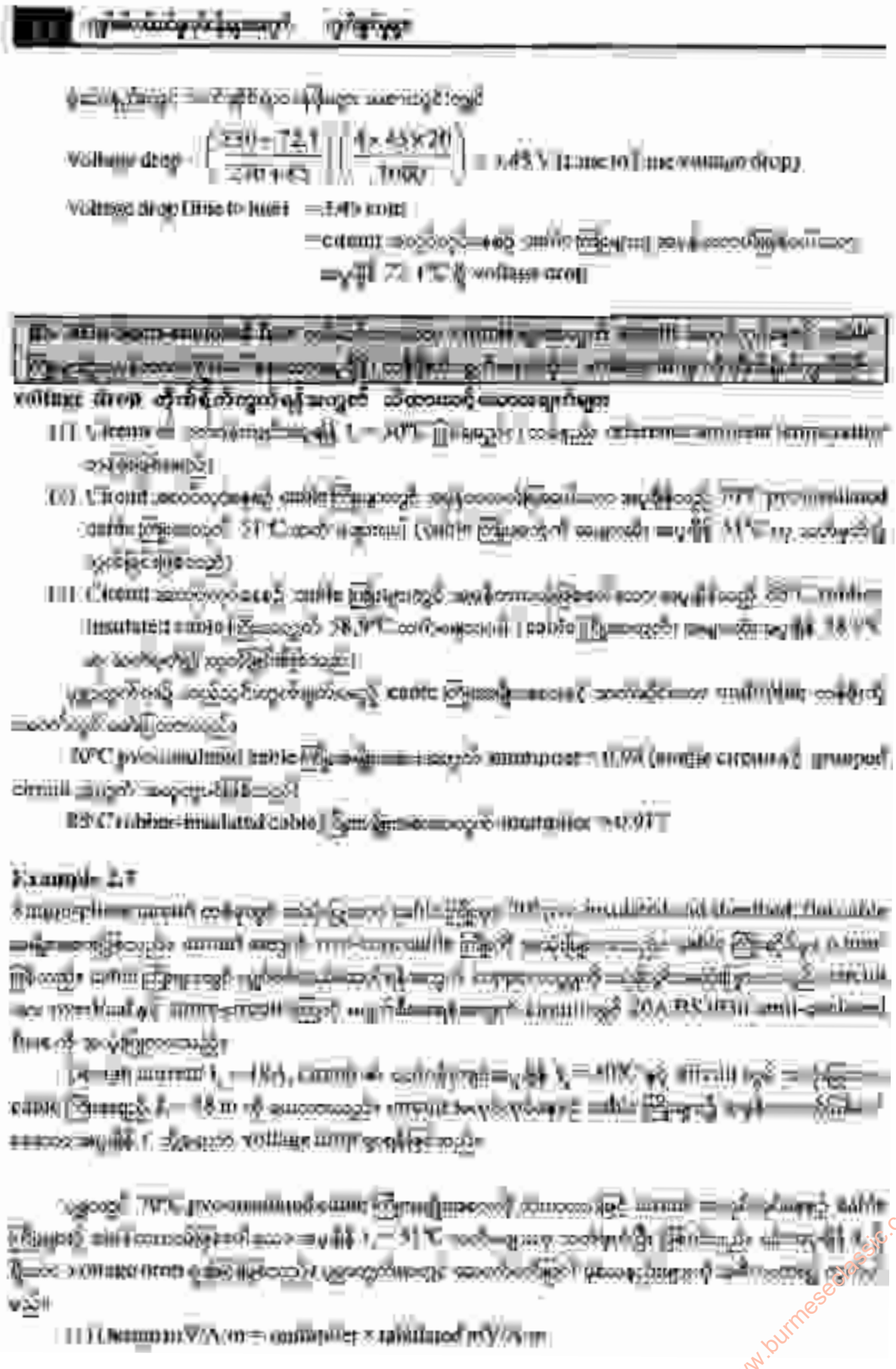

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12) voltage drop = $\frac{\text{ဇယား mV/A/m} \times \text{ဆန့်ရှည် meter}}{1000} \times$ ကေဘယ် ကြိုးများ ဦးရေ

ပုံစံ ဥပမာ တွက်ပြီးဆင့်ပုံ အကြံအစည် ပြုချက် တွက်ပါမယ်။

ပြဿနာ(1) Circuit တွင် အသုံးပြုထားသော cable အရွယ်အစားနှင့် တတ်နိုင်သော multiplier များကို

ပြဿနာ(2) tabulated mV/A/m တန်ဖိုးများအတွက် circuit တွင် အသုံးပြုထားသော cable အမျိုးအစား

ဆောင်ရွက်ထားသော Appendix 4 မှ voltage drop table များ ရှာဖွေပါ။

ပြဿနာ(3) တွေ့ရှိထားသော voltage drop table မှ တောင်းဆိုချက် တစ်ခုအတွက် ပြန်လည်ပြင်ဆင်ပါ။

ပြဿနာ(4) တွေ့ရှိထားသော voltage drop table ၏ တစ်ခုတည်းမှ tabulated mV/A/m တန်ဖိုးများကို

ပြဿနာ(5) ဖြေရှင်း mV/Amp တန်ဖိုးများကို

ပြဿနာ(6) ပြီးခဲ့သော terminal voltage drop တွေ့ပါ။

ပြဿနာ (1) Circuit တွင် အသုံးပြုထားသော cable အမျိုးအစားနှင့် တတ်နိုင်သော multiplier တွေ့ပါ။

အဖြေ။ ။ တွင် အသုံးပြုထားသော cable အမျိုးအစား = 70°C pvc-insulated and sheathed. flat cable

အဖြေ။ ။ တွင် အသုံးပြုထားသော cable အမျိုးအစား = 70°C pvc-insulated and sheathed cable အမျိုးအစား

အမျိုးအစား အလုံးရေ အတိုင်းအတာများ။

multiplier = 0.90

ပြဿနာ (2) tabulated mV/A/m တန်ဖိုးများအတွက် circuit တွင် အသုံးပြုထားသော cable အမျိုး

ဆောင်ရွက်ထားသော Appendix 4 မှ voltage drop table များ ရှာဖွေပါ။

Circuit တွင် အသုံးပြုထားသော cable အမျိုးအစား = flat 70°C pvc-insulated and sheathed cable

cable အမျိုးအစား ကိုယ်ထည် core အရေအတွက် = two-core

cable အမျိုးအစား သွပ်ကာပတ်ထားသော သို့မဟုတ် သွပ်ကာပတ်ထားသော သတ္တုချည်ကြိုးများ = ကျော်ကြားသည်

အထက်ပါ ကျွန်ုပ်တို့ Appendix 4 မှ table 9(1B) နှင့် voltage drop Table 4D2B ကို ရွေးချယ်ခဲ့သည်

ပြဿနာ(3) တွေ့ရှိထားသော voltage drop Table 4D2B မှ တောင်းဆိုချက် တစ်ခုအတွက် ပြန်လည်ပြင်ဆင်ပါ။

Circuit ကျော်ကြားသော = Single-core circuit

circuit နှင့် အသုံးပြုထားသော cable အမျိုးအစား = two-core

circuit တွင် cable အမျိုးအစား အတိုင်းအတာများ = ကျော်ကြားသော

cable အမျိုးအစား သွပ်ကာပတ်ထားသော သို့မဟုတ် သွပ်ကာပတ်ထားသော သတ္တုချည်ကြိုးများ = ကျော်ကြားသည်

အထက်ပါ [4] ကျွန်ုပ်တို့ voltage drop Table 4D2B မှ တောင်းဆိုချက် (3) ကို ရွေးချယ်ခဲ့သည်

ပြဿနာ(4) တွေ့ရှိထားသော voltage drop Table 4D2B ၏ တောင်းဆိုချက် (3) နှင့် tabulated mV/A/m တန်ဖိုးများကို

ပြန်လည်ပြင်ဆင်ပါ။

ကေဘယ်အမျိုးအစား cable အမျိုးအစား = 4 mm² 1 mm/DS = 2 ကေဘယ်အမျိုးအစား

cable အမျိုးအစား 6 mm² နှင့် tabulated mV/A/m တန်ဖိုးကို ရှာဖွေပါ။ 4 ကေဘယ်အမျိုးအစား ရှိ

voltage drop Table 4D2B ၏ တောင်းဆိုချက် = 2 mV/A/m ရှိသည်

ကေဘယ်အမျိုးအစား voltage drop = tabulated mV/A/m = 1 mV/A/m

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[illegible] (5) [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] (6) [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Example 2-8

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

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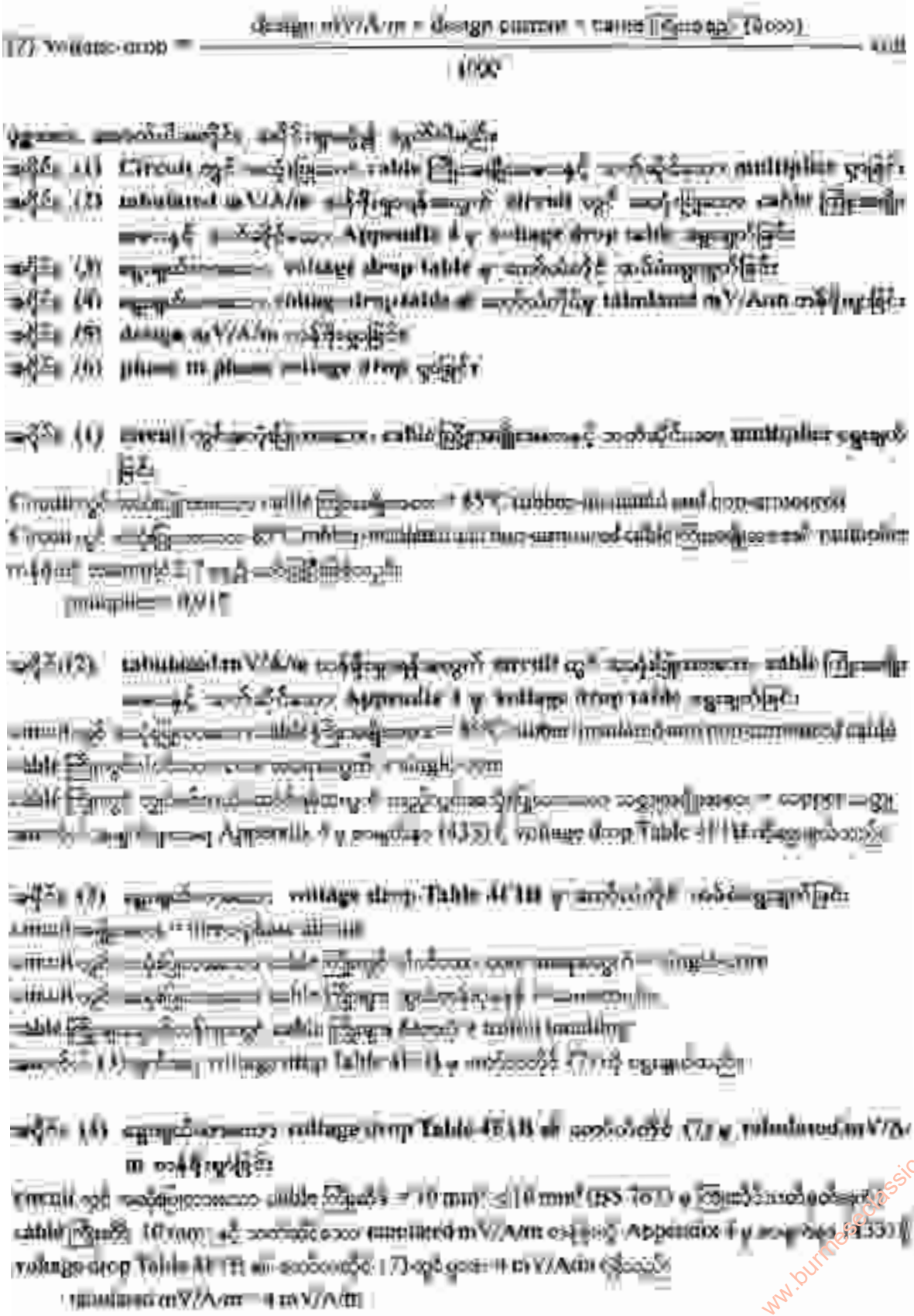

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(B) Circuit အလုပ် လိုအပ်သော cable အရွယ်အစား သတ်မှတ်ထားသော cable တို့၏ခွင့်ပြုဆုံးရှုံးမှုများနှင့် သတ်မှတ်ထားသော I_t (installed current carrying capacity) တန်ဖိုးများရှာပုံ

(C) Circuit အလုပ် လိုအပ်သော cable ကြိုးတိုင်းတာရွေးချယ်ပုံ

(C-1) Cable ကြိုးတိုင်းတာရွေးချယ်ရန်အတွက် Circuit တွင် အသုံးပြုသော Cable ကြိုးများအားလုံး၏ Automatic ဖြစ် current carrying capacity table များကိုသိရှိရန်

(C-2) ရွေးချယ်ထားသော current carrying capacity table နှင့် တစ်သင့်တော်ဆုံးဖြစ်ကြောင်း

(C-3) ရွေးချယ်ထားသော current carrying capacity table နှင့် သင်းကာဝိတ်ဆိုင်းဖြင့် I_n တန်ဖိုးများရှာပုံ

(C-4) I_n တန်ဖိုးသည် circuit breaker ထိခိုက်ပေးသော cable ကြိုးဖြစ်ပုံ

(D) Circuit အတွက်လိုအပ်သော cable ကြိုးများ၌ အပူချိန်ပြင်ဆင်ကိန်းများ အသုံးပြု I_t ရှာပုံ

(E) Circuit အလုပ်လုပ်ဆောင်ရာ cable ကြိုးများ၌ အပူကာကွယ်ပြင်ဆင်ကိန်းများ အသုံးပြု I_t ရှာပုံ ဥပမာ ground to neutral voltage drop ရှာပုံ

(E-1) Voltage drop လုပ်ငန်းစဉ်တွင် circuit တွင် အသုံးပြုသော cable ကြိုးများ၏ Approximate ခန့်မှန်း voltage drop table များကိုသိရှိရန်

(E-2) ရွေးချယ်ထားသော voltage drop table နှင့် တစ်သင့်တော်ဆုံးဖြစ်ကြောင်း

(E-3) Circuit တွင် အသုံးပြုသော cable ကြိုးအရှည်နှင့် ပတ်သက်သော tabulated mV/A/m ကိုရှာပုံ ရွေးချယ်ထားသော voltage drop table ၏ သတ်မှတ်ချက်များ

(E-4) Circuit အလုပ်လုပ်ဆောင်ရာ cable ကြိုးများ၌ ဖြစ်ပေါ်နိုင်သော phase to neutral voltage drop တွက်ချက်ပုံ

(A) Circuit အား ကာကွယ်ရန်အတွက် သော်လွန်းသော protection ရှာပုံ I_n တန်ဖိုးရှာပုံ

Circuit တွင် သင်းကာဝိတ်ဆိုင်းအား BS 1361 ဖြင့် ပြုလုပ်ထားသော 30A ဖြစ်ပြီး I_n = 30A ဖြစ်သော BS 3036 semi-enclosed fuse ဖြင့် ကာကွယ်ထားသည်ဆိုပါစို့

I_n = 30A

I_t = ခွင့်ပြုဆုံးရှုံးမှု = 36A (ကြိုးမှ ထောက်ပြချက်)

I_t = circuit အား ကာကွယ်ထားသော ကြိုးများ၏ ခွင့်ပြုဆုံးရှုံးမှုတန်ဖိုး

ဖြစ်ပါသည်။

ကြိုးများ ကာကွယ်ရန် သတ်မှတ်ထားသော ကြိုးတိုင်းတာ၏ overload protection ဖြစ်သည်ဟု ယူဆပါက $I_n = I_t$ ဖြစ်ရပါမည်။

ကြိုးတိုင်းတာ၏ current carrying capacity သတ်မှတ်ချက်အရ overload protection ဖြစ်သည်ဟုဆိုလျှင် $I_n + I_t = 30A$

I_t = 30A = circuit အား ကာကွယ်ထားသော ကြိုးများ၏ ခွင့်ပြုဆုံးရှုံးမှုတန်ဖိုး ဖြစ်ပါသည်။

(B) Circuit အလုပ် လိုအပ်သော cable ကြိုးတိုင်းတာရွေးချယ်ရန်အတွက် သတ်မှတ်ထားသော cable ကြိုးတိုင်းတာများ၏ ခွင့်ပြုဆုံးရှုံးမှုများနှင့် သတ်မှတ်ထားသော I_t (installed current-carrying capacity) တန်ဖိုးများရှာပုံ

I_t တွက်ချက်ပုံ ဖော်ပြပေးပါ။

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[illegible]

[illegible]

[illegible]

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(E) Circuit [illegible] cable [illegible] phase to neutral voltage drop [illegible]

(E-1) Voltage drop [illegible] circuit [illegible] cable [illegible] Appendix 4 [illegible] voltage drop table [illegible]

Circuit [illegible] cable [illegible] 70°C pvc-insulated and sheathed, non-armoured cable

[illegible]

[illegible] Appendix 4 [illegible] voltage drop Table 4D2B [illegible]

Circuit [illegible] multi-phase circuit

[illegible]

[illegible] reference method [illegible]

[illegible] Appendix 4 [illegible] voltage drop Table 4D2B [illegible]

(E-3) Circuit [illegible] cable [illegible] tabulated mV/A/m [illegible]

Circuit [illegible] cable [illegible] 6 mm² [illegible]

Table [illegible] 6 mm² [illegible] insulated mV/A/m [illegible] Appendix 4 [illegible] Table 4D2B [illegible] 3 [illegible] 7.3 mV/A/m [illegible]

(E-4) Circuit [illegible] cable [illegible] 1.5 [illegible] voltage drop [illegible]

Voltage drop [illegible]

$$\text{voltage drop} = \left[\frac{500\ \text{m}}{250\ \text{m}}\right] \left[\frac{\text{[illegible] mV/A/m} \times \text{[illegible] A}}{1000}\right]$$

tabulated mV/A/m [illegible]

I_t = 87.8°C = Circuit [illegible]

[illegible]

I_z = 70°C = 70°C two-insulated and sheathed, non-armoured cable [illegible]

I_n = design current = 20 A [illegible]

I = 13 m = [illegible] [illegible] cable [illegible]

[illegible]

$$\text{voltage drop} = \left[\frac{230 + 87.8}{230 + 70}\right] \left[\frac{2 \times 20 \times 13}{1000}\right] = 1.8\ \text{V}$$

[illegible] = 1.8 V = [illegible] [illegible] [illegible] voltage drop

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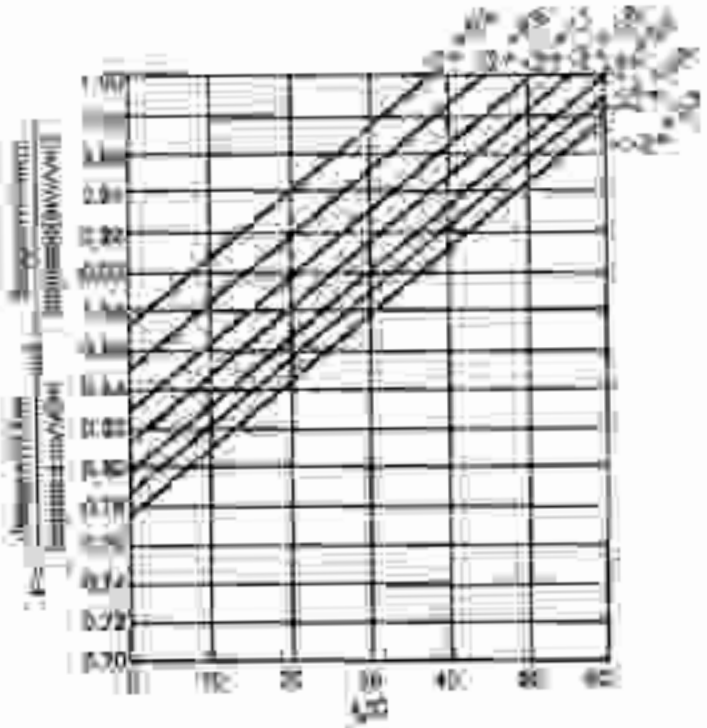

Figure 2.1

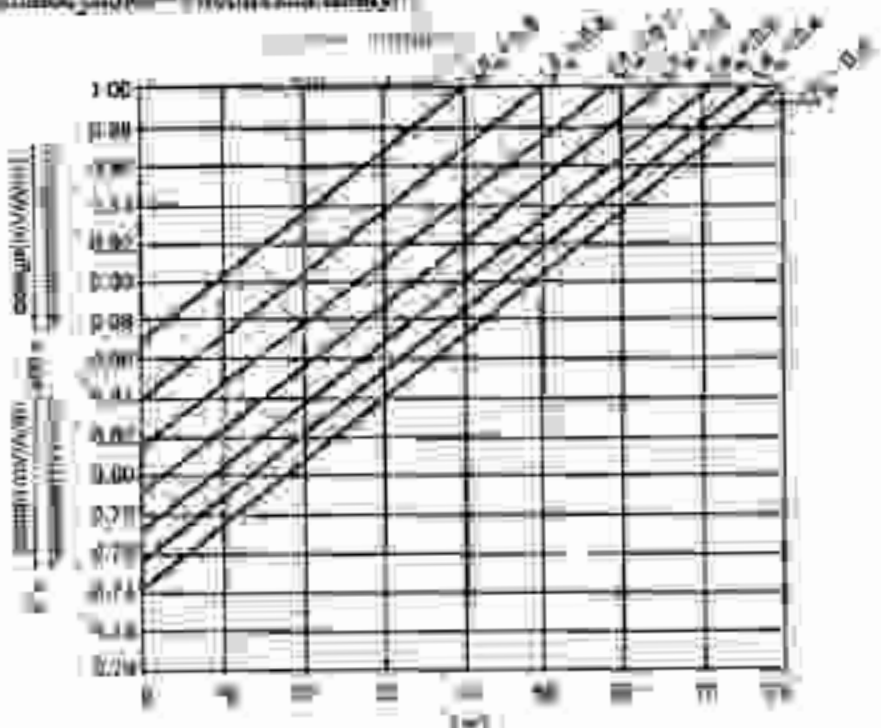

Figure 2.2

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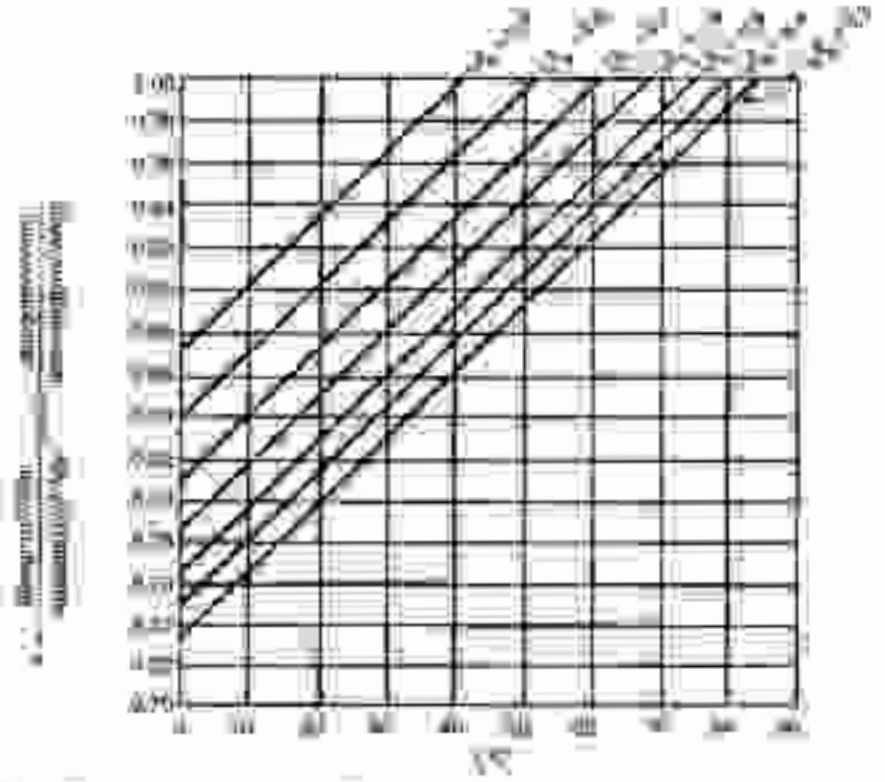

Figure 2.7 Reference [ ] for [illegible]

[illegible]

Example 2.10

[illegible] Appendix 9)

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[illegible]

[illegible]

[illegible]

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(ii) reduction factor

$$\frac{I_z}{I_n} = \frac{55}{48} = 1.146$$

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(F) Voltage drop [illegible] tabulated mV/A/m [illegible]

(i) [illegible] Approximate Voltage drop [illegible]

[illegible]

[illegible] [illegible] [illegible] [

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$$\text{voltage drop} = \frac{\text{corrected} \times \text{design}}{1000} = \text{volt (phase to phase)}$$

Example 3-11

Three-phase [illegible] 50 mm² [illegible] 415 V [illegible] 30 A [illegible] 20 m [illegible] voltage drop [illegible]

(i) $\frac{\text{design current}}{\text{actual installed current-carrying capacity}} = \frac{I_b}{I_z}$ [illegible]

(ii) corrected (mV/A/m) = $\sqrt{(\text{tabulated mV/A/m})^2 + (\text{mV/A/m})^2}$

(iii) voltage drop = $\frac{\text{corrected (mV/A/m)} \times I_b \times L}{1000}$

[illegible]

[illegible] (i) I_z [illegible] current [illegible] cable [illegible] BS7671 [illegible] Appendix 4 [illegible] current-carrying capacity table [illegible]

[illegible] (ii) [illegible] current-carrying capacity table [illegible]

[illegible] (iii) [illegible] current-carrying capacity table [illegible] cable [illegible] I_z [illegible]

[illegible] (iv) reduction factor I [illegible] $\frac{I_b}{I_z}$ current ratio [illegible]

[illegible] (v) reduction factor I [illegible]

[illegible] (vi) tabulated mV/A/m [illegible] current [illegible] cable [illegible] BS7671 [illegible] Appendix 4 [illegible] voltage drop table [illegible]

[illegible] (vii) [illegible] voltage drop table [illegible]

[illegible] (viii) [illegible] voltage drop table [illegible] cable [illegible] tabulated mV/A/m [illegible]

[illegible] (ix) design (mV/A/m) [illegible]

[illegible] (x) corrected (mV/A/m) [illegible]

[illegible] (xi) three-phase circuit [illegible] phase to phase voltage drop [illegible]

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ဥပမာ(11) voltage drop (line to line) ရှာခြင်း

[redacted]

[redacted]

Example 2.11

[redacted]

[redacted]

ဖြေရှင်းနည်း [redacted]

ဥပမာ(11) tabulated (mV/A/m) တန်ဖိုးများနှင့်အသုံးပြုတဲ့ circuit တွေ့ အတွက်တွေ့တော့ table တွေ့ကို [redacted] စာအုပ် Appendix 4 မှ voltage drop table ရယူပုံကို ရှင်းပြပါမည်။

ဥပမာ (12) ရှာဖွေထားသော voltage drop table မှ တစ်ဆင့်ထိုင် ဆက်စပ်ရှာဖွေပုံကို ရှင်းပြပါမည်။

ဥပမာ (13) ရှာဖွေထားသော voltage drop table ၏ ပတ်သက်ဆိုင်မှု circuit တွင် အသုံးပြုသော table တွေ့ကို ဘယ်လိုဆိုင်းသော tabulated (mV/A/m) တန်ဖိုးများကိုရယူပုံကို ရှင်းပြပါမည်။

ဥပမာ (14) ပုံစံအသုံးတွေ့ ဆက်စပ်ပြီး **voltage drop (line to line)** ရှာဖွေခြင်း

ဥပမာ(11) tabulated (mV/A/m) တန်ဖိုးများနှင့်အသုံးပြုတဲ့ circuit တွေ့ အတွက်တွေ့တော့ table တွေ့ကို [redacted] စာအုပ် Appendix 4 မှ voltage drop table ရယူပုံကို ရှင်းပြပါမည်။

[redacted]

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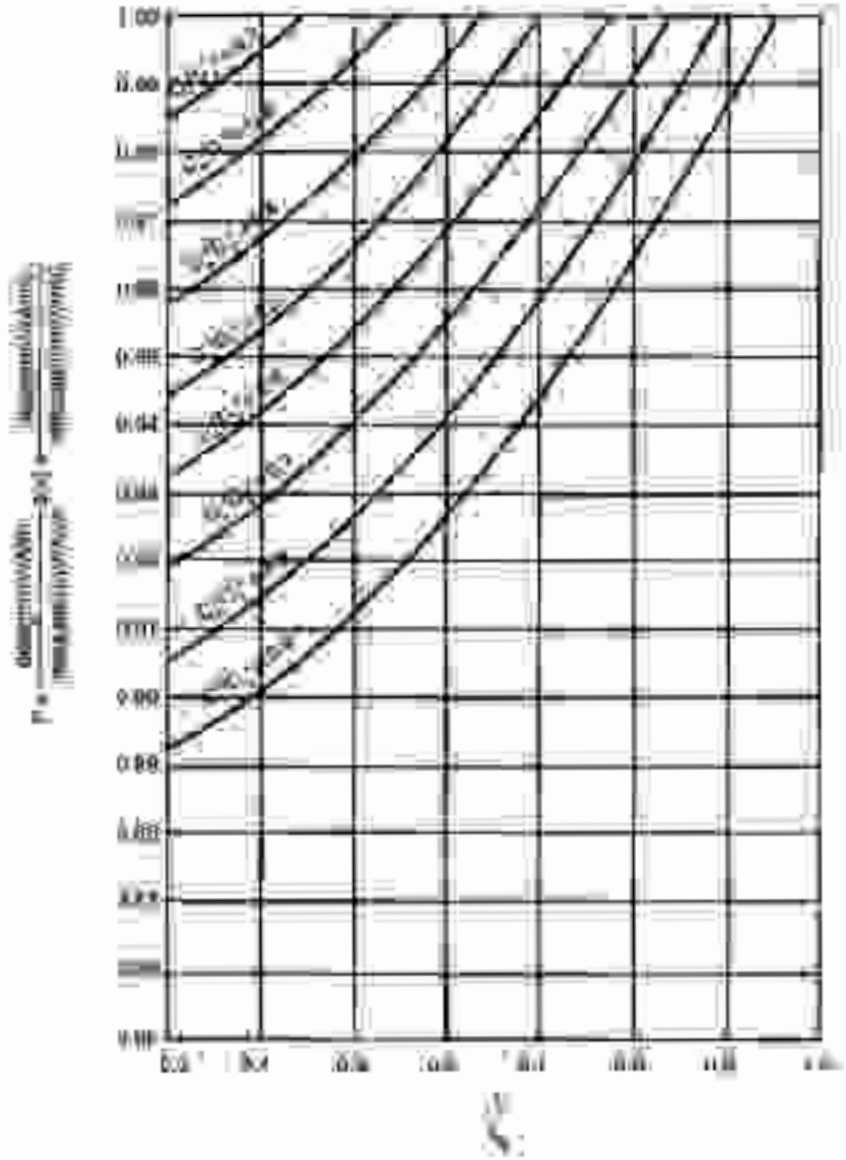

Figure 3.4

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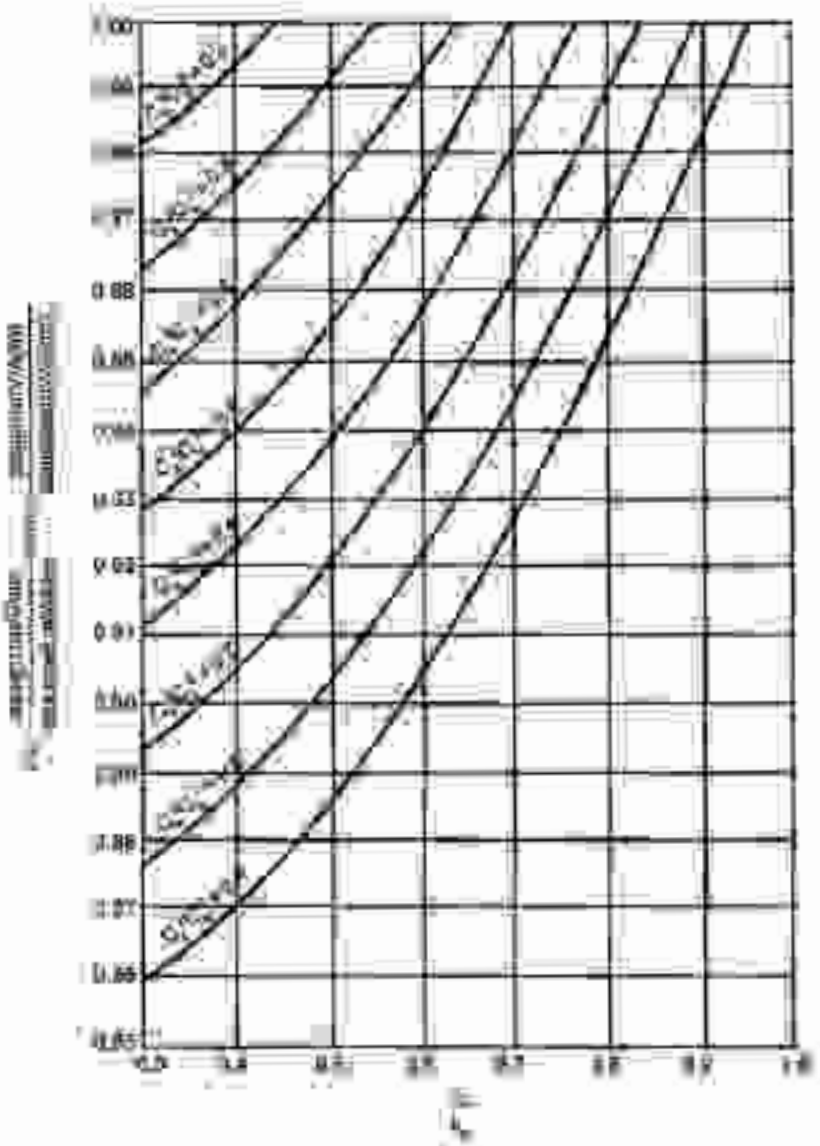

Figure 4.5 Reduction factors for 85°C rubber-insulated cables, grouped in ambient temperature of 30°C in ground

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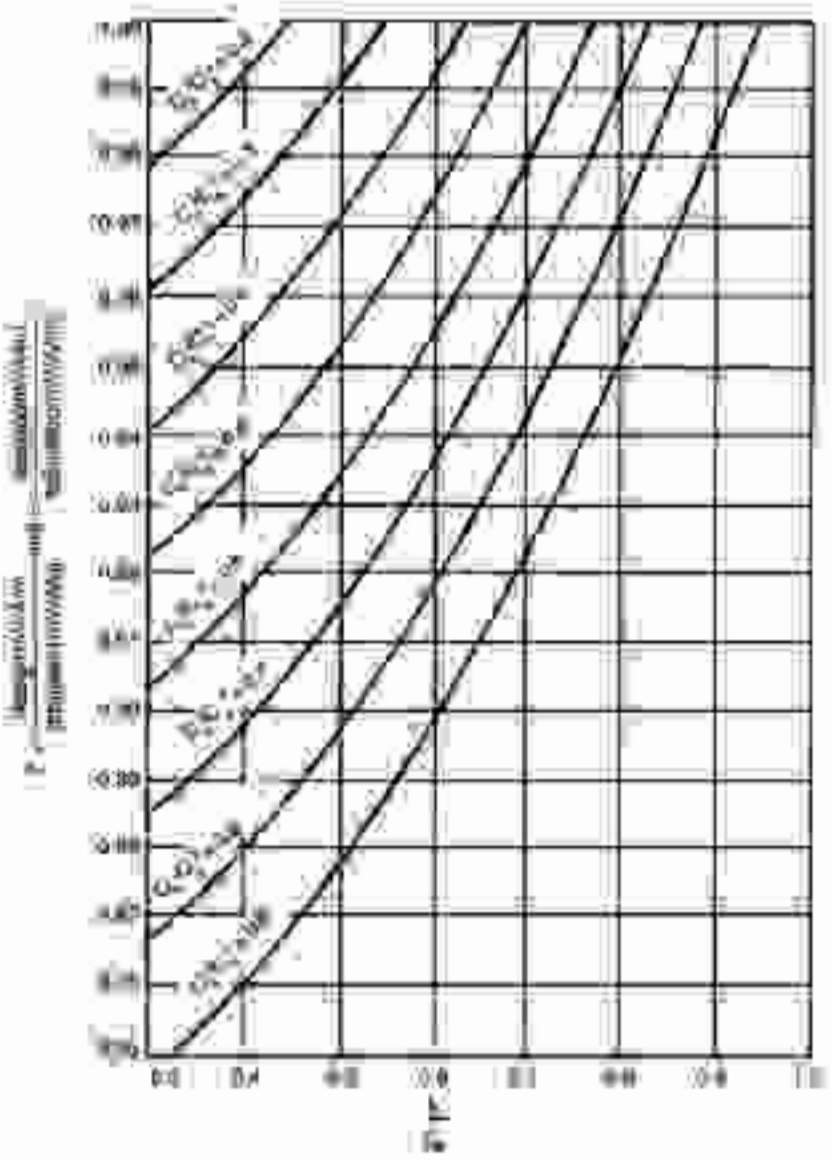

Figure 2.8

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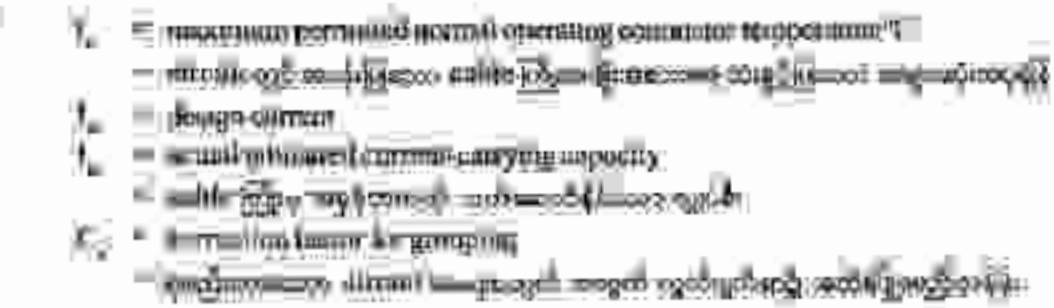
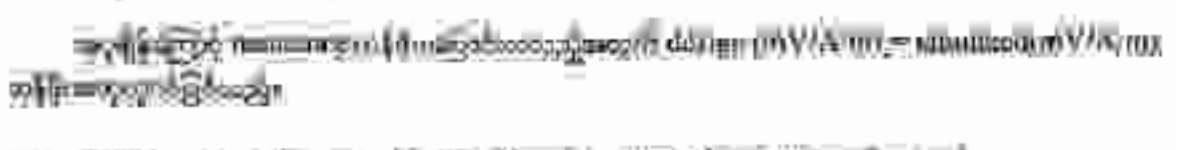

Example 2-13

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Example 13-14

Single-phase circuit ဖြစ်သော ဝန်ကို ပေးသည့် ၁၀ mm² ကြေးနီ XLPE insulated, steel wire armoured, PVC sheathed multicore cable ဖြင့် ဆွဲသွင်းထားသော circuit တစ်ခုရှိသည်။ cable ၏ ဝန်ဘက်ဆုံးအဆုံးတွင် ဝန်ကို ပေးသည့် circuit breaker ကို တပ်ဆင်ထားသည်။ circuit breaker ၏ rating သည် 40A ဖြစ်ပြီး ဝန်ဘက်ဆုံးအဆုံးတွင် ဝန်ကို ပေးသည့် circuit ၏ current သည် I_b = 27A, circuit ၏ protective device ၏ rating သည် I_n = 40A ဖြစ်သည်။ cable ၏ length သည် 100 m ရှိပြီး load power factor သည် 0.8 ဖြစ်သည်။ cable ၏ size ကို ရှာပါ။

ဖြေရှင်းချက်

အဆင့် (1) Circuit အလုပ် လိုအပ်ချက်နှင့် cable တည်ဆောက်ပုံအရ circuit အား အလုပ်ခံနိုင်ရည်အတွက် protective device ၏ rating ကို ကြည့်ပါ။

အဆင့် (2) Circuit အလုပ် လိုအပ်ချက်နှင့် cable တည်ဆောက်ပုံအရ သွားနိုင်မည့် tabulated current-carrying capacity ကို ရှာပါ။

အဆင့် (3) လက်ရှိတန်ဖိုးအား I_b ဖြင့် ဆက်လက်ပြီး cable တည်ဆောက်ပုံအရ သွားနိုင်မည့် circuit ကို အသုံးပြုသော cable ကြိုးနှင့် သက်ဆိုင်သော BS7671 ၏ Appendix 4 မှ current-carrying capacity table များကို ရှာပါ။

အဆင့် (4) များလှသောအား current-carrying capacity table မှ ဆက်စပ်ဆိုင် တပ်ဆင်ပုံများကို ရှာပါ။

အဆင့် (5) များလှသောအား current-carrying capacity table ၏ ဆက်စပ်ဆိုင်ရာ I_t တန်ဖိုးနှင့် တန်ဖိုးဆိုင်ရာ I_t (actual) tabulated current-carrying capacity နှင့် circuit အတွက် cable ကြိုးအရွယ်အစားကို ရှာပါ။

အဆင့် (6) voltage drop လျော့နည်းစေရန် BS7671 ၏ Appendix 4 မှ current လွှဲ သယ်ယူသော cable ကြိုးအရွယ်အစားနှင့် သက်ဆိုင်သော voltage drop table များကို ရှာပါ။

အဆင့် (7) များလှသောအား voltage drop table မှ ဆက်စပ်ဆိုင်ရာ တပ်ဆင်ပုံများကို ရှာပါ။

အဆင့် (8) များလှသောအား voltage drop table ၏ တပ်ဆင်ပုံနှင့် circuit လွှဲ သယ်ယူသော cable ကြိုးအရွယ်အစားနှင့် သက်ဆိုင်သော tabulated mV/A/m တန်ဖိုးများကို ရှာပါ။

အဆင့် (9) ဝန်ဘက်ဆုံးရှိ phase to neutral voltage drop ကို ရှာပါ။

အဆင့် (10) Circuit အလုပ် လိုအပ်ချက် cable ကြိုးကို သယ်ယူသော circuit အား အလုပ်ခံနိုင်ရည်အတွက် protective type ဝန်ကို ရွေးချယ်ပါ။

Circuit ကို ပေးသော protective device ၏ rating = 40A, such
I_b = 30A
I_n = 27A
I_z

$I_n = I_t$

$I_2 = I_t$

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[redacted]

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[illegible]

[illegible]

[illegible]

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[illegible]

ဥပမာ (1) voltage drop ရှာရန်အတွက် circuit တွင် အသုံးပြုထားသော cable အမျိုးအစားကို BS7671 ၏ Appendix 4 မှ voltage drop table ကိုရွေးချယ်ပါ။

ဥပမာ (2) အသုံးပြုထားသော voltage drop table မှ သတ်မှတ်ချိန် တစ်ခုခုကိုရှာပါ။

ဥပမာ (3) အသုံးပြုထားသော voltage drop table ၏အလင်းပြန်ခွင့်မှ circuit တွင် အသုံးပြုထားသော cable အမျိုးအစားနှင့် သတ်မှတ်ထားသော tabulated (mV/A/m) နှင့် tabulated (mV/Am) တန်ဖိုးများကို ရှာပါ။

ဥပမာ (4) ဖြစ်နေသည့်အခါ phase to neutral voltage drop ရှာပါ။

ဥပမာ (1) voltage drop ရှာရန်အတွက် circuit တွင် အသုံးပြုထားသော cable အမျိုးအစားကို BS7671 ၏ Appendix 4 မှ voltage drop table များမှရွေးချယ်ပါ။

circuit တွင် အသုံးပြုထားသော cable မှာ XLPE insulated and armoured cable

cable တွင် conductor မှာ two-core

cable တွင် conductor ၏ cross-sectional area မှာ 25 mm²

Appendix 4 ၏ voltage drop Table 4E4B တွင် ကြည့်ပါ။

ဥပမာ (2) အသုံးပြုထားသော voltage drop Table 4E4B ၏ သတ်မှတ်ချိန် (1) တွင် circuit တွင် အသုံးပြုထားသော cable အမျိုးအစားနှင့် သတ်မှတ်ထားသော tabulated (mV/A/m) နှင့် tabulated (mV/Am) တန်ဖိုးများကို ရှာပါ။

circuit တွင် အသုံးပြုထားသော cable မှာ 25 mm² two-core

cable ၏ conductor operating temperature မှာ 70°C

Appendix 4 ၏ voltage drop table 4E4B တွင် ကြည့်ပါ။ tabulated (mV/A/m) မှာ 1.5 mV/A/m

tabulated (mV/Am) မှာ 37 mV/Am

tabulated (mV/A/m) = 1.5 mV/A/m = resistive component of tabulated (mV/A/m)

tabulated (mV/Am) = 0.6 mV/Am = reactive component of tabulated (mV/Am)

ဥပမာ (4) ဖြစ်နေသည့် phase to neutral voltage drop ရှာပါ။

tabulated (mV/A/m) = 1.85 mV/A/m ဖြစ်ပါသည်

tabulated (mV/Am) = 0.16 mV/Am ဖြစ်ပါသည်

[illegible]

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Load power factor = [illegible]

[illegible]

[illegible]

voltage drop = [illegible]

[illegible]

voltage drop = $\frac{(1.85 \times 0.7 + 0.16 \times 0.714) \times 120 \times 30}{1000} = 6.84$ volts (phase to neutral)

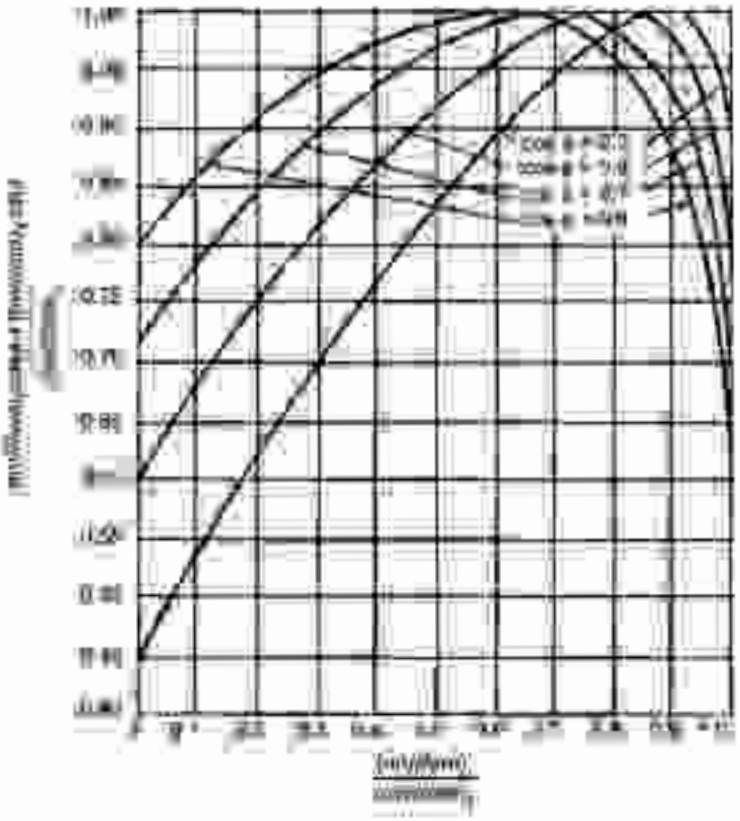

Figure 2.7 [illegible]

[illegible]

Example 2-10

[illegible]

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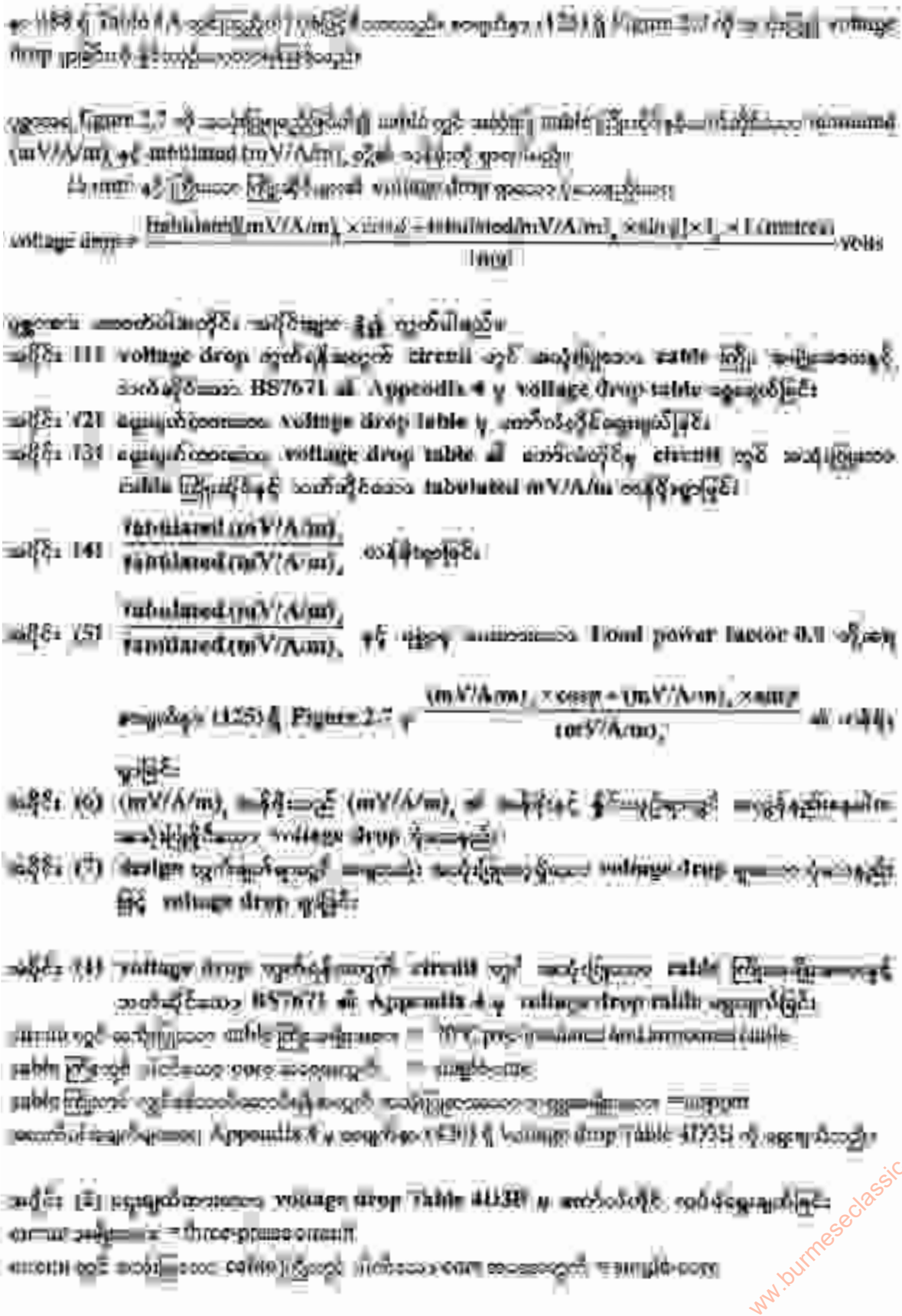

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[illegible] load power factor [illegible] voltage drop [illegible] tabulated [mV/A/m] [illegible] voltage drop [illegible] [illegible] voltage drop [illegible]

[illegible] (a) [illegible] tabulated [mV/A/m] [illegible] tabulated [mV/A/m] [illegible] voltage drop [illegible]

$$\text{voltage drop} = \frac{\text{tabulated [mV/A/m]} \times \text{amps} \times \text{length [metres]}}{1000} \text{ volts}$$

[illegible] (b) [illegible] [illegible] voltage drop [illegible]

$$\text{voltage drop} = \frac{\text{tabulated (mV/A/m)} \times I_b \times \text{length (metres)}}{1000} \text{ volts}$$

THE MORE ACCURATE APPROACH TAKING ACCOUNT OF BOTH CONDUCTOR OPERATING TEMPERATURE AND LOAD POWER FACTOR

[illegible] load power [illegible]

Example 7.17

[illegible] two-core cable [illegible] cable [illegible] cable [illegible] 16mm² [illegible] load power [illegible] 0.7 [illegible] [illegible]

[illegible] load power factor [illegible] voltage drop [illegible]

[illegible]

$$I_b = \frac{P}{V_0} = \frac{\text{[illegible]}}{230} = \text{[illegible]}\ \text{A}$$

(1) [illegible] mV/A/m = $\left(\frac{\text{[illegible]}}{\text{[illegible]}}\right)$ = [illegible] mV/A/m

(2) voltage drop = $\frac{\text{[illegible]} \times \text{load power factor} \times I_b \times \text{length [metres]}}{1000}$ volts

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ဥပမာအား အောက်ပါအတိုင်း ဆက်လက် ရှင်းလင်းပါမည်။

အဆင့် (1) ။ ။ တစ်ခုချင်းစီအတွက် circuit တွင် အသုံးပြုထား cable အရွယ်အစားများနှင့် သက်ဆိုင်ရာ BS7671 ၏ Appendix 4 မှ current-carrying capacity table များကိုရှာ။

အဆင့် (2) ။ ။ current-carrying capacity table ပုံစံ ဆောင်ထည်ခင် အပိုဖိနှိပ်ချက်များကို ရှာ။

အဆင့် (3) ။ ။ ။

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Appendix 4 မှ ဇယား 7.3.5 (i) Voltage drop Table 16/2A မှ ကေဘယ်လ် (T) ၏ conductor size ကို ရွေးပါ။ ဥပမာ cable ပြားအရွယ် 16 mm² ၏ tabulated mV/A/m တန်ဖိုးမှာ 2.9 mV/A/m ဖြစ်သည်။

calculated voltage drop = tabulated mV/A/m = 2.9 mV/A/m

ပုံစံ (B) design mV/A/m တွက်ခြင်း

design mV/A/m = $\left(\frac{\text{ဘေးဘီးအရွယ်}}{\text{ဘေးဘီးအရွယ် + } I_n}\right)$ × tabulated mV/A/m

I_n = ဘေးဘီးအရွယ်၏ rating

I_b = ဘေးဘီးအရွယ်၏ rating

tabulated mV/A/m = 2.9 mV/A/m ဟုယူပါ။

ဥပမာ design mV/A/m = $\left(\frac{\text{ဘေးဘီးအရွယ်}}{\text{ဘေးဘီးအရွယ် − } I_n}\right)$ × 2.9 mV/A/m

= 2.779 mV/A/m

ပုံစံ (C) Single phase circuit ဖြစ်ခြင်းကြောင့် phase to neutral voltage drop ရှာခြင်း

$$\text{voltage drop} = \frac{\text{design mV/A/m} \times \text{load power factor} \times I_b \times L\text{(in metres)}}{1000} \text{ volts}$$

design mV/A/m = 2.779 mV/A/m (ပုံစံ B မှ ရှာပြီး)

Load power factor = 0.7 (ပုံတွင် ပေးထား)

I_b = 65 A (design current) (ပုံတွင် ပေးထား)

L = circuit ရဲ့ အရှည် = cable ဘေးဘီးအရွယ် = 20 m (ပုံတွင် ပေးထား)

ဖြေရှင်းပုံ အပြီးသို့ ကူးခြင်း

$$\text{voltage drop} = \frac{2.779 \times 0.7 \times 65 \times 20}{1000} = 2.5 \text{ volts}$$

voltage drop = 2.5 volts = circuit အတွင်းရှိ အားသွင်းပြီး ပြုပြင်ထားသော အားသွင်းပြီး load power factor ကို ထည့်သွင်းတွက်ချက်ထားသော voltage drop ဖြစ်သည်။

Example 2-18

three-phase circuit တစ်ခုတွင် ambient temperature 70°C ရှိသော conduit တစ်ခုအတွင်း cable ဘေးဘီးအရွယ် four-core cable တစ်ခုကို ဘေးဘီးအရွယ် cable ဘေးဘီးအရွယ် ဘေးဘီးအရွယ် ဘေးဘီးအရွယ် circuit တစ်ခုတွင် ဘေးဘီးအရွယ် cable ဘေးဘီးအရွယ် ဘေးဘီးအရွယ် ဘေးဘီးအရွယ် cable ဘေးဘီးအရွယ် 95 mm², design current I_b = 160 A, circuit ရဲ့ အရှည် ဘေးဘီးအရွယ် power factor 0.8 ရှိ circuit တွင် ဘေးဘီးအရွယ် ဘေးဘီးအရွယ် I_b = 125 A ဘေးဘီးအရွယ် ဘေးဘီးအရွယ်

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[redacted]

$$[redacted] = \frac{[redacted]}{[redacted]} \times [redacted]$$

$$[redacted] = \left[\frac{[redacted]}{[redacted]}\right] \times [redacted]$$

$$[redacted] = \frac{[redacted] \times [redacted] + [redacted] \times [redacted] \times [redacted]}{[redacted]}$$

[redacted]

ဥပမာ။ [redacted]

ဖြေရှင်းချက်။ (1) [redacted] circuit တွင် [redacted] BS7671 Appendix 4 မှ current-carrying capacity table များကိုရှာပါ။

(2) [redacted] current-carrying capacity table မှ [redacted]

(3) [redacted] table ၏ [redacted] circuit တွင် [redacted] table [redacted]

(4) [redacted] circuit [redacted] table [redacted]

(5) [redacted] voltage drop [redacted] circuit [redacted] table [redacted] BS7671 ၏ Appendix 4 မှ voltage drop table များကိုရှာပါ။

(6) [redacted] voltage drop table မှ [redacted]

(7) [redacted] voltage drop table ၏ [redacted] circuit [redacted] table [redacted] tabulated mV/A/m [redacted]

(8) design mV/A/m [redacted]

(9) [redacted] phase to phase voltage drop [redacted]

(10) [redacted] BS7671 ၏ Appendix 4 မှ current-carrying capacity table [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

ဥပမာ (12) [redacted] Table 4D4A မှ [redacted]

circuit [redacted] three-phase circuit

circuit [redacted] cable [redacted] core [redacted] mm²

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[illegible]

[illegible]

[illegible]

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Example 2-17

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[redacted]

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[illegible]

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Example 2.20

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[illegible]

[illegible] overload protection [illegible] overload protection [illegible]

[illegible] overload protection [illegible] overload protection [illegible] short-circuit protection [illegible]

[illegible] overload protection [illegible] overload protection [illegible] short-circuit protection [illegible]

[illegible]

I_n = [illegible] = 40 A

I_z = 40 A = [illegible]

[illegible] I_z [illegible] cable [illegible] [illegible]

$I_z = \frac{I_n}{C_a C_g C_i}$ [illegible] 387, Appendix 4)

I_z = I_n = 40 A [illegible]

C_a [illegible]

[illegible] cable [illegible] = 70°C [illegible] cable [illegible]

I_n = 45° [illegible]

[illegible] protective device [illegible] = mcb

[illegible] [illegible] 395) [illegible] Table 4C1)

C_a = 0.79 = [illegible] 45°C [illegible]

C_g [illegible]

[illegible] = 6 circuits

[illegible] cable [illegible] [illegible]

= [illegible] [illegible] 388 [illegible] Table 4J) [illegible]

[illegible] 395) [illegible] Table 4B1) [illegible]

C_g = 0.72 = [illegible] [illegible]

C_i [illegible]

[illegible] [illegible] [illegible] [illegible] [illegible] 387 [illegible] Appendix 4 [illegible])

C_i = 1 [illegible] 387, Appendix 4 [illegible])

[illegible] protective device [illegible]

C_f = 1 [illegible] 387, Appendix 4 [illegible])

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C_t (Correction factor for ambient temperature)

C_g

C_s (Correction factor for type of overcurrent protective device)

$$I_b = \frac{22}{0.87 \times 1 \times 1} = 36.78\,A$$

$I_b = 36.78A$

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[illegible]

[illegible]

[illegible]

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[illegible]

[illegible]

[illegible]

[illegible]

BS 6717 GUIDE, BS7671:2001 (2004) TABLES

Voltage Drop

To calculate the voltage drop in volts the tabulated value of voltage drop (mV/A/m) [illegible] is multiplied by the design current of the circuit (I_b), the length of run in metres (L) and divided by 1000 to convert to volts.

$$\text{voltage drop (V)} = \frac{\text{mV/A/m} \times I_b \times L}{1000}$$

The requirements of BS7671 are deemed to be satisfied for a 230V supply if the voltage drop between the origin of the installation and a socket-outlet or load current-using equipment does not exceed 6.2 V (4 %) [illegible]

Table 6A1 Ambient Temperature Factors

Correction factors for ambient temperatures where protection is against short-circuit and overload

Type of insulation	Operating temperature	Ambient temperature °C								
		25	30	35	40	45	50	55	60	65
Thermoplastic (general purpose)	70°C	1.00	0.93	0.87	0.79	0.71	0.61	0.50	0.35	[illegible]

Note: Where the device is semi-enclosed fuse to BS 3036 the table only applies where the device is intended to provide short-circuit protection only.

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Table 6A2 Ambient Temperature Factors

Correction factors for cables exposed (or buried) in ambient temperatures other than those for which current ratings are given, for use with the current-rating tables in BS 3036

Type of insulation	Operating temperature	Ambient temperature °C								
	°C	25	30	35	40	45	50	55	60	65
Thermoplastic (general purpose pvc)	70	1.03	1.0	0.97	0.94	0.91	0.87	0.84	0.79	0.71

Table 6C Grouping Factors

Corrected factors for groups of more than one circuit of single-core cables, or more than one multicore cable

Method of installation		Number of circuits or multicore cables												
		1	2	3	4	6	8	10	12	14	16	18	20	
[illegible]		1.00	0.80	0.70	0.65	0.60	0.57	0.54	0.52	0.50	0.49	0.48	0.47	
Single layer on wall or floor (Method 1)	touching	1.00	0.85	0.79	0.75	0.73	0.72	0.72	—	—	—	—	—	
	spaced	1.00	0.94	0.91	0.90	0.89	0.88	0.87	0.86	0.85	0.85	0.84	0.84	
Single layer multicore on a perforated cable tray system (Method 11)	horizontal	0.88	0.82	0.77	0.75	0.73	0.73	0.72	0.72	—	—	—	—	
	vertical	0.91	0.87	0.85	0.83	0.81	—	—	—	—	—	—	—	
Single layer cleated on a perforated cable tray system (Method 12)	horizontal	1.00	0.87	—	—	—	—	—	—	—	—	—	—	
	vertical	1.00	—	—	—	—	—	—	—	—	—	—	—	
Single layer multicore on a ladder support (Method 13)		1.00	0.87	0.82	0.80	0.79	0.78	0.78	—	—	—	—	—	

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Table 4D1

Single-core cables having thermoplastic (PVC) or thermosetting insulation, non-armoured, with or without sheath (COPPER CONDUCTORS)

Ambient temperature: 30°C Conductor operating temperature: 70°C

CURRENT CARRYING CAPACITY (Amperes) BS 6004

[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		
[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		
[illegible]	A	A	A	A	A	A	A	A	A	A	A
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 4D2

[illegible] (per kilometre) Conductor operating temperature: 70°C

[illegible]	[illegible]	[illegible]			[illegible]			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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Table 6E1

Multicore cables having thermoplastic (pvc) insulation, non-armoured, (COPPER CONDUCTORS)

Ambient temperature: 30°C; Conductor operating temperature: 70°C

CURRENT-CARRYING CAPACITY (Amperes) IN AIR

[redacted]								
[redacted]								
[redacted]								

Table 6E2

Voltage drop:

(per ampere per metre)

Conductor operating temperature: 70°C

[redacted]			
[redacted]			

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Example 5-27

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$$I = \frac{40}{10.04 \times 1.01} = 4.23\,A$$

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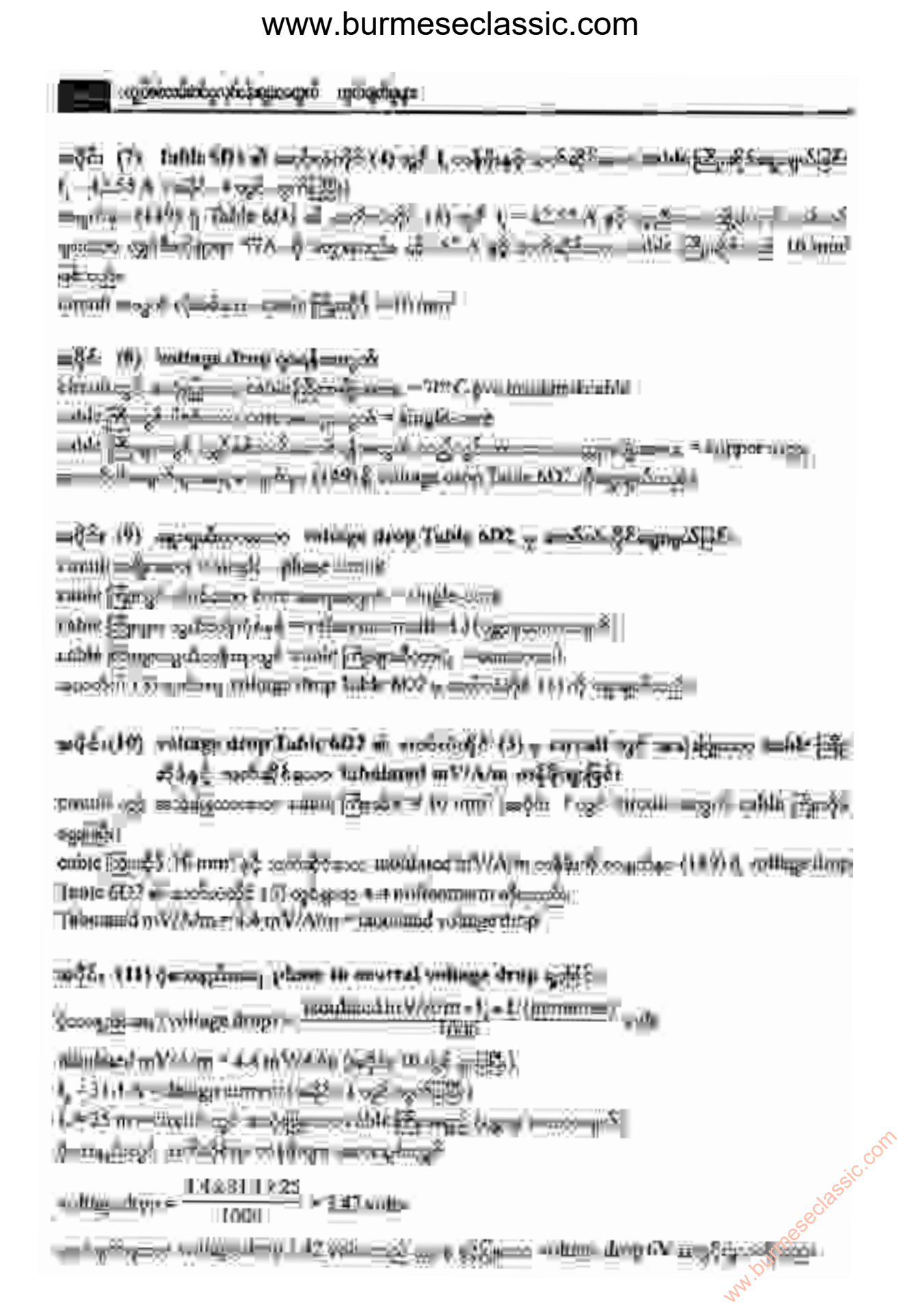

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Example 2.23

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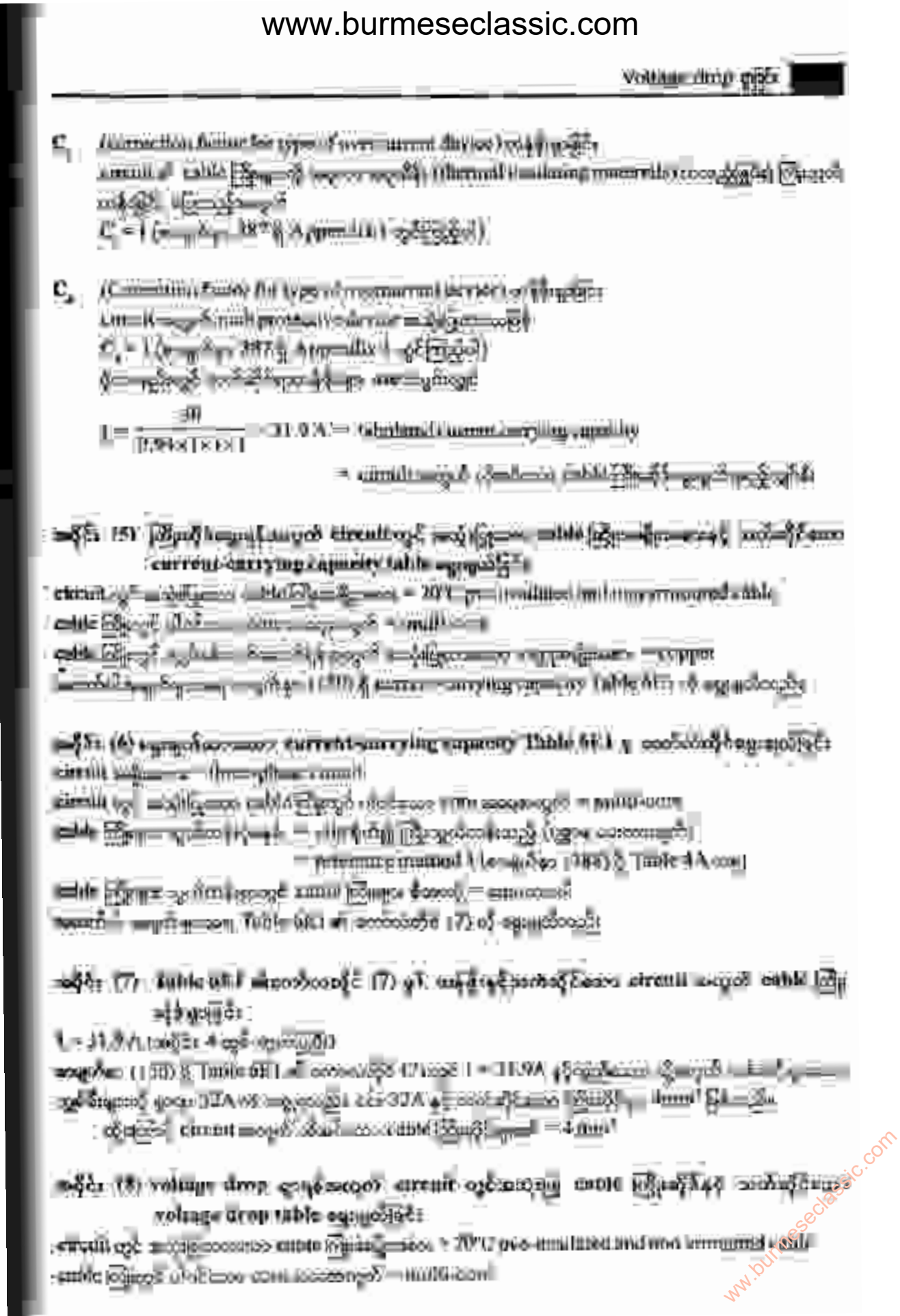

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[illegible]

[illegible]

[illegible]

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[illegible]

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[redacted] voltage drop Table 6D2 [redacted] circuit [redacted] cable [redacted] tabulated mV/A/m [redacted]

[redacted] cable [redacted] = 16 mm² [redacted]

[redacted] voltage drop table 6D2 [redacted] cable [redacted] 16 mm² [redacted]

tabulated mV/A/m [redacted] = 2.4 mV/A/m [redacted]

tabulated mV/A/m = 2.4 mV/A/m = tabulated voltage drop

[redacted] (L) voltage drop (line to line) [redacted]

$$\text{voltage drop} = \frac{\text{tabulated mV/A/m} \times I_b \times L(\text{to meet})}{1000} \text{ volt}$$

tabulated mV/A/m = 2.4 mV/A/m [redacted]

I_b = 22 A [redacted]

L = 40 m = cable [redacted]

[redacted]

$$\text{voltage drop} = \frac{2.4 \times 22 \times 40}{1000} = 2.0\ V = \frac{2.0 \times 100}{400} = 0.5\% \text{ [redacted]}$$

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CHAPTER - 3
CACULATION OF EARTH FAULT LOOP IMPEDANCE

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[illegible]

[illegible]

[illegible]

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Table 5.1 Values of $R_1 + R_2$ in milliohms (mΩ) for copper conductors at their normal ...

... accepted ... overcurrent ... fuses and circuit-breakers ...

(1) ... to BS 136, up to 100A

(2) ... and ... to BS 1610, up to 100A

(3) ... to BS 88 Part 2 and Part 6, up to 200A

(4) Type B, C and D ... to BS 60898 and RCBOs to BS EN 61009, up to 125A

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(Example 3-1)

အရိုးရှင်းဆုံးသော circuit တစ်ခုအတွက် external earth fault loop impedance ရှာဖွေခြင်း

အဖြေ(1) circuit အားလျှပ်စစ်ဓာတ်အားထောက်ပံ့သည့် power supply ကြိုးနှင့်ဖြစ်ပေါ်သောအဆင့် external earth fault loop impedance ရှာဖွေခြင်း

အဖြေ(2) Table 54b နှင့် 54c တို့မှ circuit နှင့်သက်ဆိုင်သော Table များကိုရွေးချယ်ခြင်း

အဖြေ(3) circuit တွင်အသုံးပြုထားသော phase ကြိုး(LE) နှင့်နေရာ earth ကြိုး(CR) တို့၏ earth fault loop impedance ကို Table မှ ဆင်ခြင်ဖတ်ရှုခြင်း

အဖြေ(4) တွက်ချက်ရရှိခဲ့သော circuit earth fault loop impedance ၏ milliohm အဖြေကို ohm အဖြစ်ပြောင်းလဲခြင်း

အဖြေ(5) total earth fault loop impedance ရှာဖွေခြင်း

အဖြေ(1) circuit အားလျှပ်စစ်ဓာတ်အားထောက်ပံ့သည့် power supply ကြိုးနှင့်ဖြစ်ပေါ်သောအဆင့် external earth fault loop impedance ရှာဖွေခြင်း

Z_e = ဖြစ်ပေါ်စေသောအဆင့် circuit ၏ power supply ကြိုးနှင့် earth fault loop impedance ကိုဆိုလိုသည်။ ဤသည်မှာ external earth fault loop impedance ဖြစ်သည်။

ဥပမာအားဖြင့် 0.35 ohm ဟု ယူဆကြပါစို့။

အဖြေ(2) Table 54b နှင့် Table 54c တို့မှ သက်ဆိုင်သော Table များကိုရွေးချယ်ခြင်း

circuit ကို ပံ့ပိုးပေးသော ဓာတ်အားပေးစက်ကို ရွေးချယ်ခြင်း =

circuit တွင် အသုံးပြုထားသော ဓာတ်အားပေးကြိုးအမျိုးအစားကို ရွေးချယ်ခြင်း =

ရှာဖွေရန်လိုအပ်သည်။

ဤအဆင့်တွင် Table(ကြိုးအမျိုးအစား)ကို ရွေးချယ်ခြင်းဖြစ်သည်။

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Example 5.9

[redacted]

[redacted]

ဆုံးဖြတ်ချက်(1) circuit စားသုံးမှုစက်ပစ္စည်းသည် power supply circuit ကြိုးတွင် external earth fault loop impedance ရှိ/မရှိ။

ဆုံးဖြတ်ချက်(2) Table 54B နှင့် Table 54C တို့မှ circuit နှင့်သက်ဆိုင်သော Table [redacted]

ဆုံးဖြတ်ချက်(3) circuit ချိတ်ဆက်ထားသော plug ပြတ်(P) နှင့် cpc earth ကြိုး (R_2) တို့၏ earth fault loop impedance တို့ Table [redacted]

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[illegible]

[illegible] circuit of earth fault loop impedance [illegible]

[illegible]

[illegible]

[

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[illegible]

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= 0.8 ohm/[illegible]

R_1+R_2 = [illegible] loop impedance

= 0.186 ohm/[illegible]

[illegible] loop impedance [illegible]

$Z_s = Z_e+(R_1+R_2) = 0.8 + 0.186 = 0.986$ ohm

Z_s = total earth fault loop impedance = 0.986 ohm

[illegible] [illegible] [illegible] [

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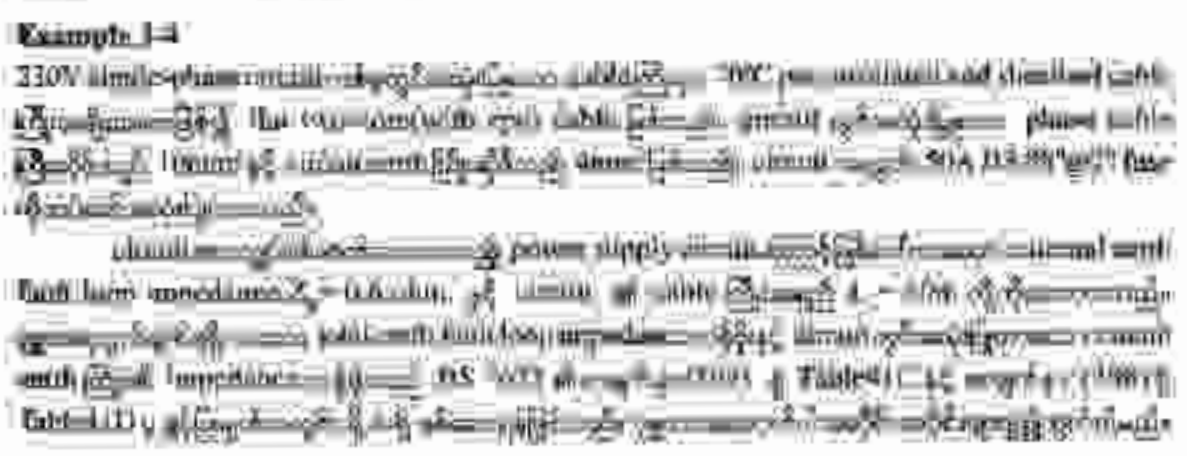
Example 1



ဖော်ပြပါ circuit အတွက် power supply circuit ကြားခံမြေစိုစွဲ circuit external earth fault loop impedance ရှာခြင်း

ဖော်ပြပါ Table 5.1 နှင့် Table 5.2 မှ circuit နှစ်ခုကို ထောက်ရှုနိုင်ပုံ။ Table များကို ပြန်ကြည့်ပါ။

circuit တွင်အသုံးပြုထားသော phase ကြိုး (R) နှစ် circuit earth ကြိုး (R) ပါဝင်သည့် circuit ၏ earth fault loop impedance ကို Table မှ milliohms တန်ဖိုးဖြင့် ရယူနိုင်ပုံ။

တူတန်ဖိုးရှိသော circuit၏ earth fault loop impedance milliohms တန်ဖိုးကို ဖြေရှင်းပုံ။

total earth fault loop impedance ကို ရှာဖွေခြင်း

ပုဂ္ဂလိကအိမ်ရာတွင် total earth fault loop impedance တန်ဖိုးသည် (0.35Ω) ဖြစ်ပြီး 100A RCD နှင့် ကိုက်ညီမှုရှိ/မရှိ ဆုံးဖြတ်ခြင်း

circuit တွင်အသုံးပြုထားသော circuit earth ကြိုး၏ impedance ကို Table မှ ကြည့်ရှု၍ တန်ဖိုးရယူခြင်း

တူတန်ဖိုးရှိသော circuit earthed impedance milliohms တန်ဖိုးကို ဖြေရှင်းပုံ။ ဖြေရှင်းခြင်း

ပုဂ္ဂလိကအိမ်ရာတွင် circuit earth ကြိုး၏ impedance တန်ဖိုးသည် (0.35Ω) ဖြစ်ပြီး 100A RCD နှင့် တွဲဖက်အသုံးပြုသော circuit earth ကြိုးအတွက် ခွင့်ပြုထားသော impedance တန်ဖိုးနှင့် ကိုက်ညီမှုရှိ/မရှိ ဆုံးဖြတ်ခြင်း

circuit တွင်အသုံးပြုထားသော power supply ကြားခံ earth ကြိုး၏ external earth fault loop impedance ရှာခြင်း

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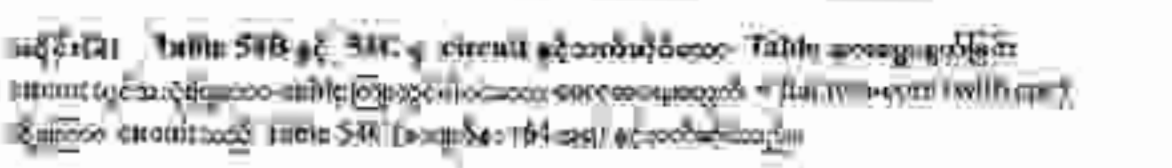

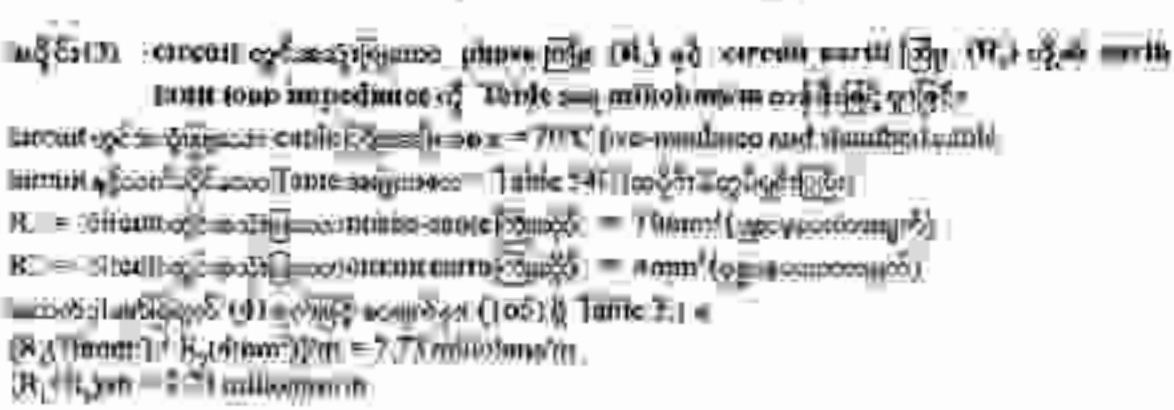

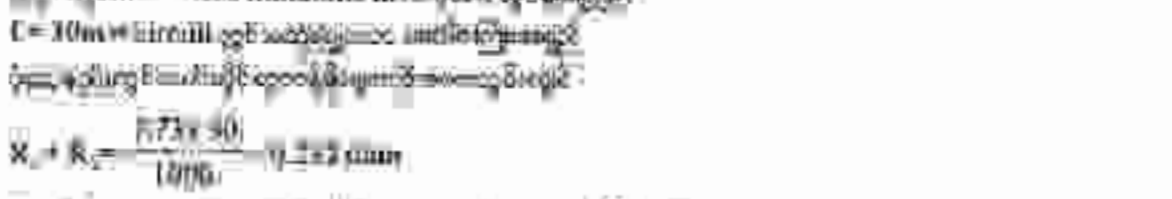

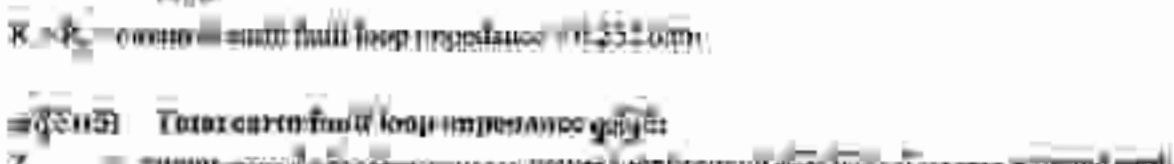

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[redacted]

Example 3-5

[redacted]

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[illegible]

[illegible]

[illegible]

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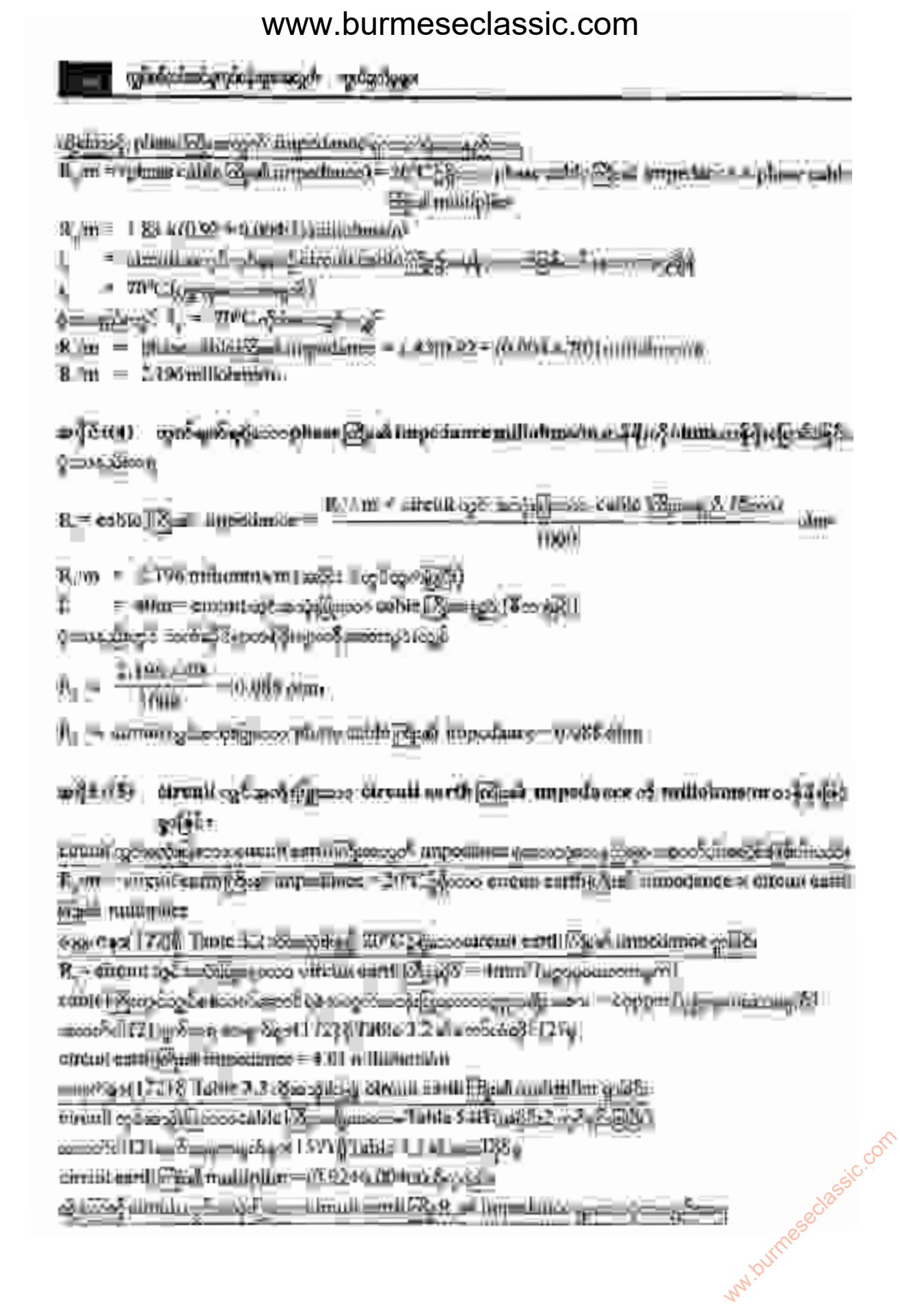

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R_{ph} = circuit earth fault impedance = 20% of circuit earth fault impedance × circuit length × multiplier

= 4.6 × [0.019 (0.004 × 1)] milliohms/m

L = circuit length in metres = 45 m (approximately)

Where L = 45 m (approximately)

R_{ph} = circuit earth fault impedance = 4.6 × [0.019 (0.004 × 45)] milliohms/m

R_{ph} = 200 milliohms/m

(b) circuit earth (R_2) impedance milliohms/m (ohm conversion)

$$R_2 = \frac{R_1 \text{ (circuit earth fault impedance milliohms/m)}}{1000} \text{ ohm}$$

R_{ph} = 5.07 milliohms/m (earth fault impedance)

L = circuit length in metres = 45 m (approximately)

R_2 = circuit earth fault impedance = 0.203 ohm

$$R_2 = \frac{5.07 \times 40}{1000} = 0.203 \text{ ohm}$$

R_2 = circuit earth fault impedance = 0.203 ohm

(c) circuit fault loop impedance (Z_s):

R_1 = circuit phase conductor impedance = 0.038 ohm (approx.)

R_2 = circuit earth fault impedance = 0.203 ohm

circuit earth fault loop impedance =

$R_1 + R_2$ = (0.0038 + 0.203) ohms

$R_1 + R_2$ = circuit earth fault loop impedance = (0.29) ohm

(d) total earth fault loop impedance (Z_s):

Z_e = external loop impedance = supply phase conductor + supply earth conductor impedance

= 0.35 ohm (approx.)

$R_1 + R_2$ = circuit earth fault loop impedance

= 0.291 ohm (approx.)

Z_s = total earth fault loop impedance

total earth fault loop impedance =

$Z_s = Z_e + (R_1 + R_2)$

Z_s = 0.35 + (0.29) ohm

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Example 3-6.

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[illegible]

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$$R_1 + R_2 = \frac{1.29 \times 37}{1000} = 0.0038 \text{ ohm}$$

$R_1 + R_2$ = circuit (r) + earth fault loop impedance = 0.0038 ohm

(iii) Calculate the total earth fault loop impedance Z_s

Z_s = external earth fault loop impedance + power supply (source) earth fault loop impedance

= 0.8 ohm (given) + 0.038 ohm

$R_1 + R_2$ = circuit (r) + earth fault loop impedance

= 0.0038 ohm (above calculation)

Total earth fault loop impedance Z_s

$Z_s = Z_e + (R_1 + R_2)$

$= 0.8 + 0.0038 = 0.8038$ ohm

Z_s = total earth fault loop impedance = 0.8038 ohm

Table 3.9 Multipliers corresponding to t_c °C for various values of t_c to be applied to the resistance values of Table 8.2

Temperature °C	Copper conductors	Aluminium conductors	XLPE conductors
10	1.08	1.08	1.08
20	1.04	1.04	1.04
30	1.00	1.00	1.00
40	0.96	0.96	0.96
50	0.92	0.92	0.92

For single-phase circuits the minimum earth fault loop impedance Z_s is given by:

$$\frac{\text{Tabulated } mV/A/m}{2 \times 1000} \times \left[\frac{230 \times U_o}{230 + U_o}\right] \times \text{length of circuit in metres}$$

For three-phase circuits the minimum earth fault loop impedance Z_s is given by:

$$\frac{\text{Tabulated } mV/A/m}{\sqrt{3} \times 1000} \times \left[\frac{230 \times U_o}{230 + U_o}\right] \times \text{length of circuit in metres}$$

Example 3.9

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[illegible]

[illegible]

[illegible]

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[illegible]

[illegible]

[illegible]

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$$R_1 = \frac{\rho \cdot \ell}{A} \times \left[\frac{230 - 115}{230 - 85}\right] = [illegible]$$

R_1 = phase cable ရဲ့ resistance = 0.0778 ohm

ဥပမာ (6) : circuit နဲ့ earth fault ဖြစ်တဲ့အခါ circuit earth loop R_e ရဲ့ တန်ဖိုးသတ်မှတ်ချက်ကို ရေးဆွဲပြသပါ။

circuit earth loop [illegible]

$$I_f = \frac{V_o}{Z_e}$$

I_f = [illegible]

= [illegible]

V_o = [illegible]

= 230V (ဖေးစ်မှ နျူထရယ်)

ဖြေရှင်းချက်။

$$I_f = \frac{V_o}{Z_e} = \frac{50 \times 230}{\Omega} = 135°C$$

I_f = [illegible] = 135°C

ဥပမာ (7) : circuit earth [illegible] voltage drop ရှာပုံ

[illegible]

[illegible]

R_e = [illegible]

[illegible] 10mm² [illegible]

[illegible] 10mm² [illegible] = [illegible] mV/A/m

ဥပမာ (8) : circuit earth [illegible] resistance ရှာပုံ

[illegible] mV/A/m [illegible] = 0.0 mV/A/m

V_d = [illegible]

I_f = [illegible]

[illegible]

$$R_e = \text{circuit earth [illegible] resistance} = \frac{\text{tabulated mV/A/m}}{2 \times 1000} \times \left[\frac{230 + I_f}{230 + I_f}\right] \times \text{circuit [illegible]}$$

(ဖြေရှင်းချက်)

ဖြေရှင်းချက်ပြုလုပ်ပုံ [illegible]

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$$R_2 = \frac{4.8}{2 \times 1000} \times \left(\frac{230 + 135}{230 + 85} \right) = 40 \text{ ohm}$$

R_2 = [illegible] $= 0.120$ ohm

[illegible] circuit earth fault loop impedance [illegible]:

R_1 = circuit [illegible] cable [illegible] resistance
$= 0.778$ ohm (table 5 [illegible])

R_2 = circuit [illegible] earth [illegible] resistance
$= 0.120$ ohm (table 5 [illegible])

circuit earth fault loop impedance (Z_s) [illegible]

$R_1 + R_2 = R_1 + R_2 + 0.778 + 0.120 = 0.898$ ohm

$R_1 + R_2$ = circuit earth fault loop impedance = 0.898 ohm

Example 3-9

Three-phase circuit [illegible] cable [illegible] 70°C pvc-insulated and -sheathed cable [illegible] earth-wire cable [illegible] cable length [illegible] BS 7671 [illegible] protective device [illegible] circuit [illegible] 16mm² [illegible]

circuit [illegible] cable [illegible] L = 50m, circuit all [illegible] I_b = 13°C; circuit [illegible] circuit cable [illegible] [illegible] I = 45°C [illegible] circuit 5 earth fault [illegible] circuit all earth fault loop impedance (R_2 = 8 [illegible]

[illegible] circuit 3 earth fault [illegible] cable [illegible] [illegible] circuit all earth fault loop [illegible] circuit [illegible] cable [illegible] circuit all earth fault loop [illegible] circuit earth fault [illegible] circuit earth fault loop [illegible] (R_2) [illegible] I = 45°C [illegible] I_b [illegible]

Three-phase circuit cable [illegible]

$$R = \frac{\text{[illegible]}}{2 \times 1000} \times \left(\frac{\text{[illegible]}}{\text{[illegible]}} \right) = \text{circuit [illegible] cable [illegible]}$$

[illegible]

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[redacted]

[redacted]

[redacted]

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R_e = earth fault loop impedance

X_e = earth fault loop impedance

(i) three-phase

R_e = earth fault loop impedance

X_e = earth fault loop impedance

Z_e = earth fault loop impedance

R_e = resistance component of Z_e

X_e = reactance component of Z_e

R_1 = phase resistance

R_2 = circuit earth resistance

X_1 = phase reactance

X_2 = circuit earth reactance

(mV/A/m) = resistive voltage drop

mV/A/m = reactive voltage drop

L = earth fault loop length

(ii) three-phase

(i)

(ii)

(iii)

CALCULATION TAKING ACCOUNT OF TRANSFORMER IMPEDANCE

(i)

(ii)

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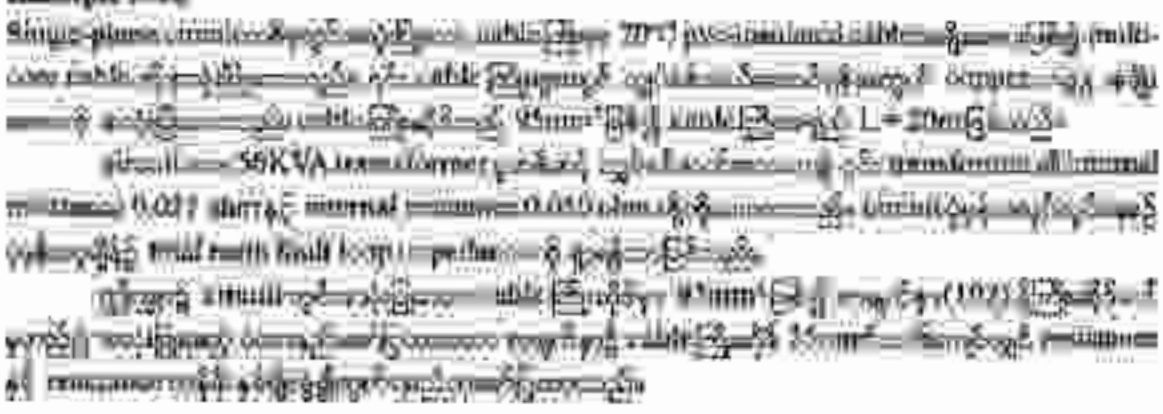
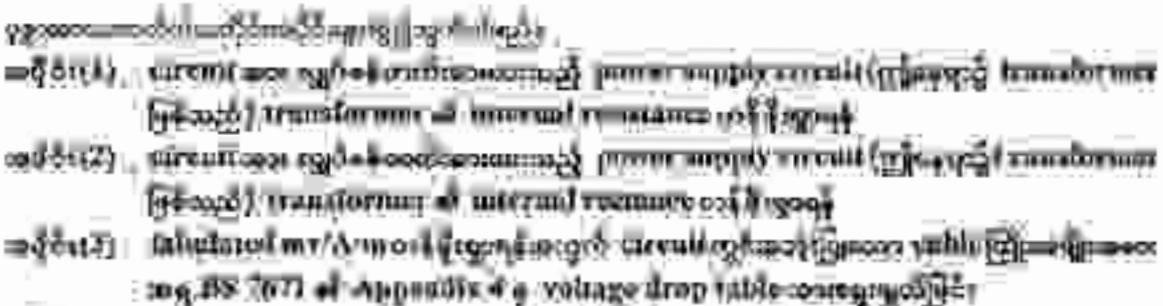
Example 5.10



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[illegible]

$$R_1 + R_2 = \frac{0.87 \times 20}{1000} = 0.0094 \text{ ohm}$$

[illegible] circuit earth fault loop impedance [illegible] resistance [illegible]

[illegible] single-phase circuit [illegible] phase conductor (R_1) [illegible] circuit earth conductor (R_2) [illegible] resistance [illegible]

[illegible]

Z_s = circuit earth fault loop impedance [illegible] resistance [illegible]

$$= \frac{[\text{mV/A/m}) \times L}{1000} \text{ ohm} \quad \text{(single phase circuit [illegible] } = \text{[illegible]} = 95\text{sq}$$

tabulated (mV/A/m) = 0.130 mV/A/m [illegible]

L = 20m = circuit [illegible] (one-way)

[illegible]

$$Z_s = Z_e + \frac{(R_1 + R_2)m}{1000} = 0.005 + 0.009 \text{ ohm}$$

[illegible] Total earth fault loop impedance [illegible]

R_1 = 0.027 ohm [illegible]

X_1 = 0.050 ohm [illegible]

$R_1 + R_2$ = 0.0094 ohm [illegible]

$X_1 + X_2$ = 0.0031 ohm [illegible]

circuit [illegible] 95mm² [illegible] 35mm² [illegible] L = 50m [illegible]

$$Z_s = \sqrt{[R_1 + (R_1 + R_2)]^2 + [X_1 + (X_1 + X_2)]^2} \text{ ohm}$$

$$Z_s = Z_e + \sqrt{(0.027 + 0.0094)^2 + (0.050 + 0.0031)^2} \text{ ohm} = 0.063 \text{ ohm}$$

Z_s = total earth fault loop impedance = 0.063 ohm

Example 3-4

[illegible]

[illegible]

[illegible]

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[illegible]

ဆိုင်း(1) circuit [illegible] power supply circuit [illegible] transformer [illegible] transformer's internal resistance [illegible]

ဆိုင်း(2) circuit [illegible] power supply circuit [illegible] transformer [illegible] transformer's internal resistance [illegible]

ဆိုင်း(3) circuit's tabulated mV/A/m [illegible] circuit [illegible] [illegible] BS7671 [illegible] Appendix 4 [illegible] voltage drop table [illegible]

ဆိုင်း(4) [illegible] voltage drop table [illegible]

ဆိုင်း(5) circuit's phase [illegible] (R) [illegible] resistance tabulated (mV/A/m) [illegible]

ဆိုင်း(6) circuit's phase [illegible] (R) [illegible] resistance tabulated (mV/A/m) [illegible]

ဆိုင်း(7) circuit's phase [illegible] (R) [illegible] circuit's earth [illegible] (R_2) [illegible]

ဆိုင်း(8) circuit's phase [illegible] (X_L) [illegible] circuit's earth [illegible] (X_2) [illegible]

ဆိုင်း(9) circuit's earth fault loop impedance [illegible]

ဆိုင်း(10) circuit's load side [illegible] total earth fault loop impedance [illegible]

[illegible]

(1) circuit [illegible] cable [illegible] 8 [illegible] 70mm² [illegible] (R_1) [illegible] 35mm² [illegible] [illegible] [illegible] earth fault loop impedance [illegible] [illegible] [illegible]

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$R_1 + R_2$ = phase နှင့် circuit earth ကြိုးတို့၏ ပေါင်းလဒ် = 0.028 ohm

အဆင့်(၆) circuit ၏ phase cable (R_1)နှင့် circuit earth (R_2)၏ resistance တန်ဖိုးများ

$$X_1 + X_2 = \frac{\text{ကေဘယ်၏ reactance (mV/A/m)} \times \text{ကေဘယ်အရှည် (meter)}}{\sqrt{3} \times 1000} \text{ ohm}$$

ကေဘယ်၏ reactance (mV/A/m) = 0.11 (သတ်မှတ်ချက်အရ)

ကေဘယ်အရှည် = 45m (ပုံတွင်ပါရှိသည်)

$$X_1 + X_2 = \frac{0.11 \times 45}{\sqrt{3} \times 1000} = 0.00286 \text{ ohm}$$

$X_1 + X_2$ = phase နှင့် circuit earth ကြိုးတို့၏ reactance = 0.00286 ohm

အဆင့်(၇) circuit ၏ earth fault loop impedance တွက်ခြင်း

$R_1 + R_2$ = အဆင့်(၅)တွင် circuit earth ကြိုးတို့၏ resistance တန်ဖိုး = 0.0280 ohm (အဆင့်(၅)တွင်ရရှိသည်)

$X_1 + X_2$ = အဆင့်(၆)တွင် circuit earth ကြိုးတို့၏ reactance တန်ဖိုး = 0.00286 ohm (အဆင့်(၆)တွင်ရရှိသည်)

အဆင့်(၈) circuit ၏ load side ဖြစ်သော total earth fault loop impedance ရှာခြင်း

အဆင့်(၇)တွင်ရရှိသော 32mm² ကေဘယ်ကြိုး၏ 45m earth fault loop impedance

$$Z_s = \sqrt{(R_1 + R_2 + R_3)^2 + (X_1 + X_2)^2}$$

$R_1 + R_2$ = 0.0280 ohm (အဆင့်(၅)တွင်ရရှိသည်)

$X_1 + X_2$ = 0.00286 ohm (အဆင့်(၆)တွင်ရရှိသည်)

$R_3 + R_4$ = 0.0280 ohm (အဆင့်(၄)တွင်ရရှိသည်)

$X_3 + X_4$ = 0.00722 ohm (အဆင့်(၄)တွင်ရရှိသည်)

အဆင့်(၈)တွင် ပေါင်းလဒ်များကို ပေးထားသော formula ထဲသို့ ထည့်သွင်းတွက်ချက်ခြင်း

$$Z_s = \sqrt{(0.056 + 0.0286)^2 + (0.0 + 0.00722)^2} \text{ ohm}$$

Z_s = circuit ၏ impedance တန်ဖိုး (၀.၀၅၆ ohm) earth fault loop impedance = 0.056 ohm

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CALCULATIONS WHERE CABLE ARMOURING IS USED AS THE PROTECTIVE CONDUCTOR

Table 3.5 Impedance of steel wire armouring for 70°C pvc-insulated cables to BS 6346 having annealed copper conductors at 20°C in milliohms per metre

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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[illegible]

[illegible]

[illegible]

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$R_2 = \frac{1.8 \times 34 \times 1/16}{1000} = 0.2$ ohm

R_2 = (ကိုင်းဝိုင်းအရွယ်အစား) ground conductor resistance = 0.2 ohm

အဆင့်(5) circuit ၏ earth fault loop impedance ရှာခြင်း

R_3 = earth loop အလုပ်ဖြစ်စေသော main earth terminal resistance = 0.28 ohm

R_4 = ပထဝီမြေကြီးအတွင်းရှိ ground-wire ၏ resistance = 0.3 ohm

$R_3 + R_4$ = circuit ၏ earth fault loop impedance

$R_3 + R_4$ = 0.28 + 0.3 = 0.58 ohm

$R_3 + R_4$ = circuit ၏ earth fault loop impedance = 0.58 ohm

အဆင့်(6) total earth fault loop impedance ရှာခြင်း

Z_e = ကျွန်တော်တို့အသုံးပြုထားသော power supply source ၏ earth fault loop impedance
တစ်နေရာတည်းက external earth fault loop impedance = 0.35 ohm (ဥပမာအားဖြင့်)

$R_1 + R_2$ = ကြားခံ earth fault loop impedance

= 0.488 ohm (အဆင့်(4)မှရလဒ်)

Z_e = total earth fault loop impedance

total earth fault loop impedance ရှာဖော်နည်း

Z_s = $Z_e + (R_1 + R_2)$ = 0.35 + 0.488 = 0.838 ohm

Z_s = total earth fault loop impedance = 0.838 ohm

Example 3.13

One-line circuit ကြည့်ပြီး ဖြေဆိုပါ။ 10/0 give-limited and armoured cable ဖြင့် ကြိုးတပ်ထားသော ring circuit တစ်ခုတွင် cable ကြိုးတပ်ပုံမှာ wall ထဲတွင် plaster ပြန်ရိုက်ထားသည်။ circuit ၏ 30A Type B mcb [BS EN] ကို ဖြုတ်ထားသော circuit ၏ phase နှင့် neutral ကြားတွင်

ကြားခံ cable အရှည် = 12m, external earth fault loop impedance ၏ resistance R_1 = 0.35 ohm, ဤ external earth fault loop impedance ၏ reactance X_1 = 0.00 ohm ဖြစ်သည်။ ထို့ကြောင့် total earth fault loop impedance ကို ရှာဖွေပါ။ ထို့နောက် total earth fault loop impedance တန်ဖိုး 0.82 ohm ဖြင့် ဤ circuit ၏ fault current ကို ရှာဖွေပါ။

ဖြေရှင်းချက်

အဆင့်(1) circuit ကြည့်ပြီး ကျွန်တော်တို့ power supply circuit ကြိုးတပ်ထားသော external earth fault loop impedance ၏ resistance ကိုရှာဖွေပါ။

အဆင့်(2) circuit ကြည့်ပြီး ကျွန်တော်တို့ power supply circuit ကြိုးတပ်ထားသော external earth fault loop impedance ၏ reactance ကိုရှာဖွေပါ။

အဆင့်(3) phase ကြိုးနှင့်အတူ protected circuit ထဲသို့ ဝင်ရောက်သွားသော circuit တွင် ကြိုးတပ်ထားသော cable ကြိုးတန်ဖိုးအား BS 7671 ၏ Appendix 4 မှ voltage drop ဇယားမှ ရှာဖွေပါ။

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[illegible]

[illegible]

[illegible]

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(v) circuit ၏ earth fault loop impedance ကို၊

R_1 = phase conductor resistance = 0.456 ohm (ခန့်မှန်းတွက်ချက်ရရှိသော)

R_2 = cpc resistance = 0.16 ohm (ခန့်မှန်းတွက်ချက်ရရှိသော)

$R_1 + R_2$ = 0.616 + 0.16 ohm

$R_1 + R_2$ = total earth fault loop impedance = 0.776 ohm

(vi) final earth fault loop impedance ကို၊

R_e = external earth fault loop impedance ၏ resistance

= 0.25 ohm (ပေးထားသည်)

X_e = external earth fault loop impedance ၏ reactance

= 0.22 ohm (ပေးထားသည်)

$R_1 + R_e$ = external earth fault loop impedance

= 0.227 ohm (ပေးထားသည်)

Z_e = final earth fault loop impedance

phase cable cross-sectional area ကြီးသောအခါ cpc cross-sectional area သေးသောကြောင့် total earth fault loop impedance တွက်ရသည်။

$$Z_e = \sqrt{(R_1 + R_e)^2 + X_e^2}$$

ဖြစ်သောကြောင့်

$$Z_e = \sqrt{(0.25 + 0.227)^2 + (0.2)^2} = 0.525 \text{ ohm}$$

ဖြစ်သည်။ ထို့ကြောင့် final earth fault loop impedance သည် 0.525 ohm ဖြစ်သည်။

Example 3.14

single-phase circuit တစ်ခုတွင် cable သည် 70°C pvc-insulated and armoured cable ဖြစ်ပြီး 50mm² phase conductor နှင့် 16mm² cpc ပါသော cable ဖြစ်သည်။ circuit တွင် residual current device (rcd) ပါဝင်သည်။ circuit ၏ length သည် 37m ဖြစ်သည်။ circuit ၏ external earth fault loop impedance သည် $Z_e = 0.35$ ohm ဖြစ်ပြီး $R_e = 0.27$ ohm ဖြစ်သည်။ circuit ၏ earth fault loop impedance ကို တွက်ချက်ပါ။

ဖြေရှင်းချက်

cable သည် 50mm² phase conductor နှင့် 16mm² cpc ပါသော cable ဖြစ်သည်။

circuit ၏ external earth fault loop impedance ၏ resistance တန်ဖိုးကို ပေးထားသည်။

ထို့ကြောင့် circuit ၏ power supply circuit ၏ external earth fault loop impedance ၏ resistance တန်ဖိုးကို

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ဥပမာ(2) circuit တစ်ခုတွင် power supply circuit ကြည့်ရှုခြင်းအားဖြင့် external earth fault loop impedance ၏ resistance တန်ဖိုးရှာခြင်း။

ဥပမာ(3) circuit တစ်ခုတွင် phase cable ကြိုးတွင်းရှိ resistance tabulated (mV/A/m) နှင့် resistance tabulated (mV/A/m) ကို အသုံးပြုခြင်းအားဖြင့် circuit တစ်ခု၏ တစ်ဝက်ခန့် cable ကြိုးတွင်းရှိ 85 °C ရှိ Appendix 4 မှတဆင့် voltage drop table အသုံးပြုခြင်း။

ဥပမာ(4) အကြံပေးထားသော voltage drop table မှ တစ်ဆင့်ပြောင်းလဲအသုံးပြုခြင်း။

ဥပမာ(5) circuit phase cable ကြိုးတွင်းရှိ resistance tabulated (mV/A/m) တန်ဖိုးနှင့် voltage drop table မှတဆင့်ပြောင်းခြင်း။

ဥပမာ(6) circuit phase cable ကြိုး resistance တန်ဖိုးရှာခြင်း။

ဥပမာ(7) circuit phase cable ကြိုးတွင်းရှိ resistance tabulated(mV/A/m) တန်ဖိုးနှင့် voltage drop table မှတဆင့်ပြောင်းခြင်း။

ဥပမာ(8) circuit phase cable ကြိုး reactance တန်ဖိုးရှာခြင်း။

ဥပမာ(9) circuit နှစ်ခုပေါင်းထားသော armoured cable တွင်ပါရှိသော armouring steel-wire ၏ 20°C ရှိသော resistance component of impedance တန်ဖိုးရှာခြင်း။

ဥပမာ(10) armouring steel-wire ၏ 60°C ရှိသော resistance component of impedance တန်ဖိုးရှာခြင်း။

ဥပမာ(11) armouring steel-wire ၏ 20°C ရှိသော reactance component of impedance တန်ဖိုးရှာခြင်း။

ဥပမာ(12) armouring steel-wire ၏ 60°C ရှိသော reactance component of impedance တန်ဖိုးရှာခြင်း။

ဥပမာ(13) total earth fault loop impedance တန်ဖိုးရှာခြင်း။

ဥပမာ(1) circuit တစ်ခုတွင် power supply circuit ကြည့်ရှုခြင်းအားဖြင့် external earth fault loop impedance ၏ resistance တန်ဖိုးရှာခြင်း။

R_e = circuit တစ်ခုတွင် power supply circuit ကြည့်ရှုခြင်းအားဖြင့် external earth fault loop impedance ၏ resistance တန်ဖိုး

= resistance component of external earth fault loop impedance

= 0.07 ohm (ခန့်မှန်းတွက်ချက်ရရှိသော)

ဥပမာ(2) circuit တစ်ခုတွင် power supply circuit ကြည့်ရှုခြင်းအားဖြင့် external earth fault loop impedance ၏ reactance တန်ဖိုးရှာခြင်း။

X_e = circuit တစ်ခုတွင် power supply circuit ကြည့်ရှုခြင်းအားဖြင့် external earth fault loop impedance ၏ reactance တန်ဖိုး

= reactance component of external earth fault loop impedance

= 0.10 ohm (ခန့်မှန်းတွက်ချက်ရရှိသော)

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[illegible]

[illegible]

[illegible]

[illegible]

$$R_1 = \frac{0.93 \times 37}{2 \times 1000} = 0.017 \text{ ohm}$$

[illegible]

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...ION SITE GUIDE, BS7671 16th EDITION ... TABLE ...

TABLE 2A SEMI ENCLOSED FUSES

Maximum measured earth fault loop impedance (in ohms) which will ensure that protective device is a semi-enclosed fuse to BS3036

[redacted]

TABLE 2B BS 88 fuses

Maximum measured earth fault loop impedance (in ohms) which will ensure that protective device is a fuse to BS 88

[redacted]

TABLE 2C

Maximum measured earth fault loop impedance (in ohms) which will ensure that protective device is a fuse to BS 1361

[redacted]

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TABLE 3D

Maximum [redacted] earth fault loop impedance (in ohms) [redacted] protective device [redacted] to BS 3871 / or BS EN 60898 or BS 88 or BS EN 60269 [redacted] 0.4 and 5 seconds disconnection times

[redacted]	[redacted]											
[redacted]												
[redacted]												
[redacted]												

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TABLE 9H

Ambient temperature multipliers to Table 9A

Ambient temperature	Correction factor
	0.00
	1.00

TABLE 9C Standard devices

Multipliers to be applied to Table 9A where conductors are enclosed in conduit or trunking

Circuit protection	Overload protection		

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ရေးဖွဲ့သောအကြောင်းအရာများ

(1) earth fault loop impedance တွေ့ရှိခြင်း

(2) circuit တစ်ခုရဲ့ residual current device (rcd) တပ်ဆင်ထားခြင်းရဲ့ မှန်ကန်မှုကို စစ်ဆေးခြင်း

Example 5.1

single phase lighting circuit တစ်ခုကို ကြည့်ပါ။ circuit ကို 70°C thermoplastic insulated copper conductors နဲ့ တပ်ဆင်ထားပြီး live conductors တွေက 1.0mm² cpc နဲ့ တွဲပြီး conduit တစ်ခုအတွင်း တပ်ဆင်ထားတယ်။ circuit ကို 30A rewirable fuse နဲ့ protect လုပ်ထားတယ်။ circuit ရဲ့ length က 17m ဖြစ်ပြီး ambient temperature က 30°C ဖြစ်တယ်။

(1) ဒီ circuit ရဲ့ maximum earth fault loop impedance Z_s = 0.77 ohms ဖြစ်ကြောင်း ပြသပါ။

(2) ဒီ circuit ရဲ့ total earth fault loop impedance က 0.77 ohms ထက်နည်းကြောင်း ပြသပါ။

(3) ဒီ circuit ရဲ့ earth fault loop impedance ကို ဘယ်လိုတိုင်းတာရမလဲ ဆိုတာကို ဖော်ပြပါ။

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[illegible] circuit [illegible] AS/NZS 3760 [illegible]

[illegible]

[illegible] circuit [illegible] power supply circuit [illegible] external earth fault loop impedance [illegible]

[illegible] Table 5.4B [illegible] Table 5.4C [illegible] circuit [illegible] table [illegible]

[illegible] circuit [illegible] cable [illegible] resistance [illegible] Table 7C [illegible] multiplier [illegible]

[illegible] phase [illegible] circuit earth [illegible] 10°C [illegible] resistance per metre [illegible]

[illegible] circuit [illegible] cable [illegible] resistance [illegible]

[illegible] total earth fault loop impedance [illegible]

[illegible] circuit [illegible] t_c = 25°C [illegible] correction factor [illegible]

[illegible] circuit [illegible] AS/NZS 3000 [illegible] total earth fault loop impedance [illegible] Table [illegible] AS/NZS 3760 [illegible] total earth fault loop impedance [illegible]

[illegible] AS/NZS 3760 [illegible] AS/NZS 3000 [illegible] total earth fault loop impedance [illegible] 25°C [illegible] total earth fault loop impedance [illegible]

[illegible] AS/NZS 3760 [illegible] total earth fault loop impedance [illegible] AS/NZS 3000 [illegible] residual current device (RCD) [illegible]

[illegible] circuit [illegible] earth fault current [illegible]

[illegible] AS/NZS 3000 [illegible] earth fault current [illegible]

[illegible] circuit [illegible] power supply circuit [illegible] external earth fault loop impedance [illegible]

Z_e = [illegible] power supply [illegible] common [illegible]

= 0.35 ohm [illegible]

[illegible] Table 5.4B [illegible] Table 5.4C [illegible] circuit [illegible] Table [illegible]

circuit [illegible] conductor [illegible] compensate [illegible] = [illegible]

two-core cable [illegible] circuit [illegible] Table 5.4C [illegible]

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ဘဝဝါဒ(3) circuit တလျှောက်လုံးရှိသော earth ကြိုးများရဲ့ ခြွင်းချက်များအား အလေးထားရမည်ဖြစ်ပြီး ထိုသို့ ကြိုးများရဲ့ resistance များကို တွက်ချက်ခြင်းအား Table 9C မှ multiplier များဖြင့်

အဝိဇ္ဇာ(4) phase cable နှင့် circuit earth ကြိုးတို့၏ အပေါ် ရှိသော resistance per metre တန်ဖိုးများ ဖြစ်၏။

အဝိဇ္ဇာ(5) circuit တလျှောက်လုံးရှိသော phase cable နှင့် circuit earth ကြိုးတွင်ပြုလုပ်ထားသော အလျှို့ဝှက် အရ resistance per metre တန်ဖိုးများကြောင့် circuit ၏ earth fault loop impedance တန်ဖိုးကို resistance per metre ဖြင့် ရှာဖွေနိုင်ပါသည်။

အဝိဇ္ဇာ(6) circuit ၏ earth fault loop impedance တန်ဖိုးကို ထိုးတန်ဖိုးဖြင့် ရှာဖွေပါသည်။

အဝိဇ္ဇာ(7) total earth fault loop impedance ဖြစ်သည်။

အဝိဇ္ဇာ(8) circuit ၏ဝန်ကျင်ကူးမှုကို အပေါ် အကျယ် correction factor ဖြစ်သည်။

အဝိဇ္ဇာ(9) circuit တွင်းရှိပြုလုပ်ထားသော 40A BS 88 Part 2 fuse တစ်ခုသည် ခွင့်ပြုထားသောအတိုးအများဆုံး earth fault loop impedance ရှိသည်ဟု အဆိုပါ BS 7671 မှတတ်ဆိုထားသော Table များမှဖြစ်သည်။

အဝိဇ္ဇာ(10) ဖော်ပြထားသော Table မှ 40A BS 88 Part 2 fuse အတွက်ခွင့်ပြုထားသောအများဆုံး earth fault loop impedance တန်ဖိုးများဖြစ်သည်။

ဝေဒနာ(11) circuit ၏ ယာယီဝန်ကျင်ကူးမှုကို ပံ့ပိုးပေးရန် 40A BS 88 part 2 fuse ၏ BS 7671 မှ သတ်မှတ်ထားသော အများဆုံး earth fault loop impedance တန်ဖိုးများဖြစ်သည်။

ဝေဒနာ(12) အသုံးချကိရိယာများတွင် total earth fault loop တန်ဖိုးသည် BS 7671 ဖြစ်ရပြည့်မီစေရန်နှင့် ကိုက်ညီမှုရှိမရှိ ပြောင်းလဲခြင်းနှင့် residual current device တပ်ဆင်သင့်ခြင်းရှိ၊ မရှိခြင်းတို့ ဖြစ်သည်။

ဝေဒနာ(13) circuit ၏ fault ကြောင့်ဖြစ်ပေါ်လာသည့် earth fault current ဖြစ်သည်။

ဝေဒနာ(14) လျှပ်စီးကြိုးတစ်ခုတွင် earth fault current သည် 40A BS 88 Part 2 fuse မှ earth fault ကြိုးတွင် လျှပ်စီးကြိုးတစ်ခုတွင် ခေတ္တခဏတည်ရှိခြင်း (disconnection time) ကိုဖြစ်သည်။

ဝေဒနာ(1) circuit တလျှောက်ရှိ၌ power supply circuit များကြိုတင်ခန့်မှန်းထားသော external earth fault loop impedance

R_1 = circuit တလျှောက်ရှိ၌ power supply circuit များကြိုတင်ခန့်မှန်းထားသော external earth fault loop impedance

= 0.35 ohm (ခန့်မှန်းတန်ဖိုး)

ဝေဒနာ(2) Table 54H နှင့် Table 54C မှ circuit နှင့်သက်ဆိုင်သော table များကိုရှာပါ။

circuit လျှပ်စီးကြိုးများ table ကြိုးများတွင်ပါဝင်သော table များကို cable ကြိုးများတွင် conduit သယ်ယူပို့ဆောင်ရေးအတွက် ခွင့်ပြုထားသော ပမာဏ (ampacity) ကိုရှာဖွေရန် circuit များကို table 54F (ဇယားများ) တွင်ပါဝင်သော ဇယားများဖြစ်သည်။

ဝေဒနာ(3) circuit တလျှောက်လုံးရှိသော cable ကြိုးများရဲ့ ခြွင်းချက်များအား အလေးထားရမည်ဖြစ်ပြီး cable ကြိုးများရဲ့ resistance များကိုတွက်ချက်ခြင်းအား Table 9C မှ multiplier များဖြင့်

ဥပမာ အဝေးတစ်ထပ်ရှိသော Table များကြိုတင်ခန့်မှန်းထားသော = Table 54C (ကြိုးတွင်းရှိခြင်း)

ဥပမာ တွင်းတစ်ခုရှိသော cable ကြိုးများ = 70°C ambient temp

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[illegible]

multiplier = 1.2

ဥပမာ (4) phase cable တစ်ခု၏ circuit earth တစ်ခုလုံး၏ 20°C ရှိသော resistance per metre ကို တွက်ချက်ပါ။

phase cable ၏ size R = 16mm² (ကြေးနီ)

circuit earth ၏ size R_2 = 4mm² (ကြေးနီ)

cable တစ်ခုလုံး၏ ပျမ်းမျှအပူချိန်မြင့်တက်မှုကို 10°C ဟု ခန့်မှန်းထားသည်။ [illegible]

R_1 + R_2 (16mm²/4mm²) = 1.23 milliohms/m

= 10°C ရှိသော phase နှင့် circuit earth တစ်ခုလုံး၏ resistance per metre

ဥပမာ (5) circuit တစ်ခုတွင် phase cable နှင့် circuit earth တစ်ခုလုံး ပြောင်းလဲမှုမရှိသော circuit ၏ earth fault loop impedance ကို resistance per metre ဖြင့် တွက်ချက်ပါ။

cable တစ်ခုလုံး၏ အလျား = [illegible] cable ၏ resistance = [illegible] = multiplier =

20°C ရှိသော (R_1 + R_2)/m ၏ resistance = 4.23 milliohms/m (ပြဿနာ ၄ မှ ရရှိသည်)

multiplier = 1.2 (ပြဿနာ ၃ မှ ရရှိသည်)

[illegible]

(R_1+R_2) = 4.23 × 1.2 milliohms/m = circuit earth fault loop impedance ၏ [illegible]

[illegible] = earth fault loop impedance တစ်ခု

ဥပမာ (6) အထက်ပါပြဿနာတွင် circuit ၏ earth fault loop impedance ကို milliohms/m ဖြင့် ရှာပါ။

(ပြဿနာ ၅)

R_1 + R_2 = (R_1 + R_2)/m × circuit တစ်ခုလုံး၏ cable အလျား (meters) / 1000 ohm

(R_1+R_2)/m = 4.23 × 1.2 milliohms/m (ပြဿနာ ၃ မှ ရရှိသည်)

L = circuit တစ်ခုလုံး၏ cable အလျား = 35m (ပြဿနာ ၄ မှ ရရှိသည်)

[illegible]

R_1 + R_2 = $\frac{4.23 \times 1.2 \times 35}{1000}$ = 0.178 ohm

R_1+R_2 = circuit earth fault loop impedance = 0.178 ohm

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[redacted]

[redacted]

[redacted]

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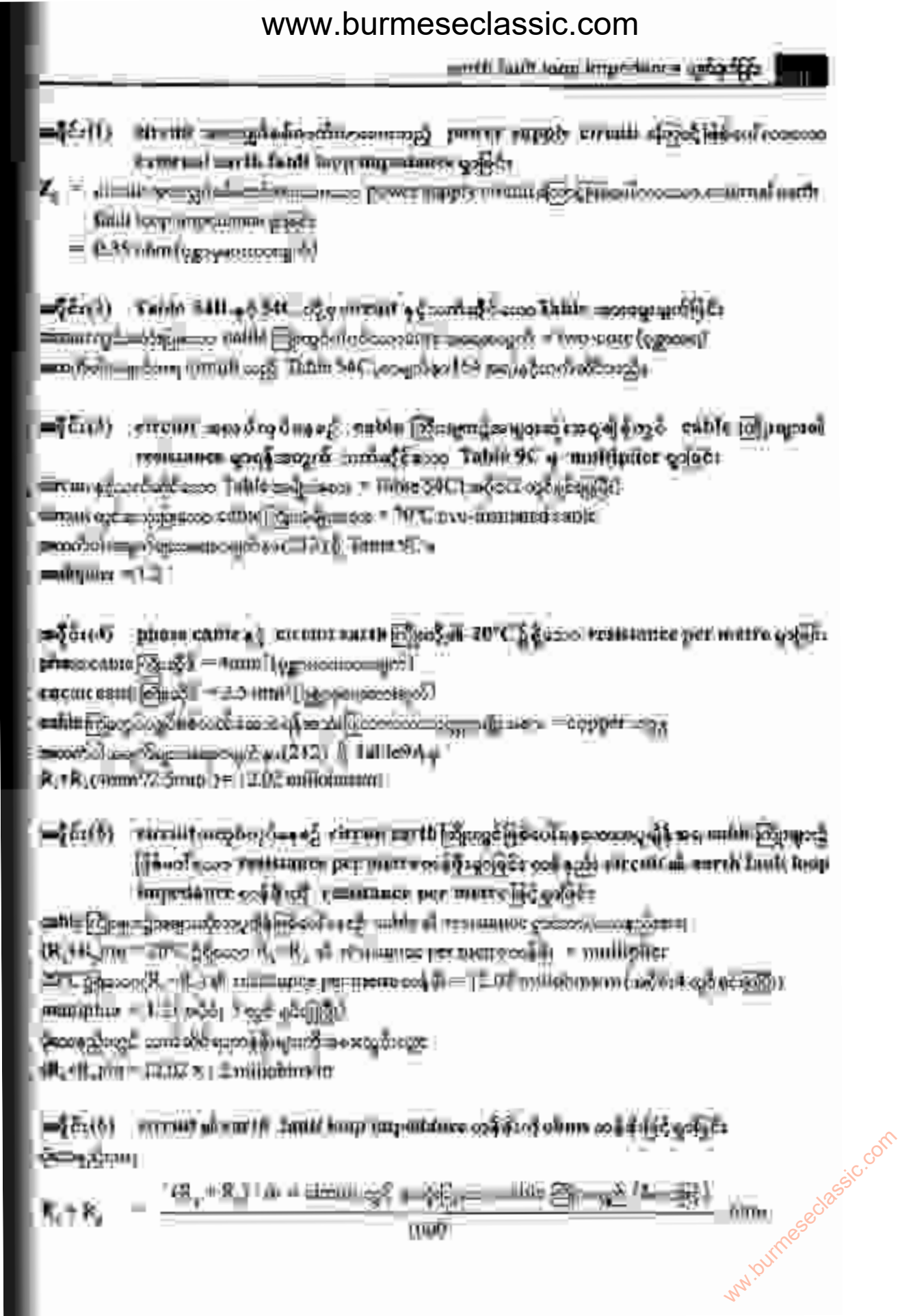

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CHAPTER-4

CALCULATIONS CONCERNING PROTECTIVE CONDUCTOR CROSS-SECTIONAL AREAS

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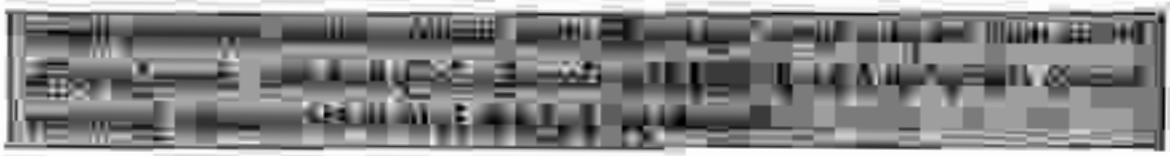

Example-4-1

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(4)

(5)

(6)

(7)

(8)

(1)

I_{sc} =

=

V =

=

Z_s =

$$Z_s = \frac{V_{\quad}}{I_{\quad}} - \frac{\quad}{8000} \text{ ohm}$$

(2)

(3)

R_1 =

R_2 =

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[illegible]

[illegible]

[illegible]

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[illegible] circuit ၏ earth fault loop impedance ရှာပုံ

$R_1 + R_2$ = circuit ၏ earth fault loop impedance

= 0.332 ohm (ပစ်စာ ၏ တွေ့ရှိချက်)

အပိုင်း (ဃ) total earth fault loop impedance ရှာပုံ

Z_e = external earth fault loop impedance

(0.45 ohm (မည်သို့ ရှာရသနည်း))

$R_1 + R_2$ = circuit ၏ earth fault loop impedance

= 0.332 ohm (ပစ်စာ ၏ တွေ့ရှိချက်)

Z_s = total earth fault loop impedance

$Z_s = Z_e + (R_1 + R_2)$

ဤတွင် Z_e ကို ပစ်စာ ၏ တွေ့ရှိချက်အရ ယူသုံးရမည် :

Z_s = 0.45 + 0.332 = 0.782 ohm

အပိုင်း (ငါး) current of fuse-wire ကြိုးသေးသည်ဖြစ်ရာ earth fault loop current ရှာပုံ

Z_s = total earth fault loop impedance

= 0.782 ohm (အပေါ်တွင် တွက်ပြီးသား)

V = Phase to neutral voltage = 230V

I_a = ဟောက်ခဲ့သော fuse-wire ကြိုးသေးသည်ဖြစ်ရာ earth fault current

earth fault loop current ရှာပုံ ဖော်မြူလာမှာ

$$I_a = \frac{V}{Z_s} = \frac{\text{Voltage}}{\text{total earth fault loop impedance}} = \frac{230}{0.782} = 294\text{A}$$

အပိုင်း (စ) current ဟာ earth fault ဖြစ်တဲ့အခါ fuse ကပျော်ဖို့ (disconnection time) ကို ဘယ်လောက်ကြာမလဲ

circuit ထဲက earth fault ဖြစ်တဲ့အခါ fuse ကပျော်ဖို့ current ဟာ 294A ဖြစ်ပါတယ်။ ဒီ current ကို fuse ရဲ့ time current characteristic ဇယား [BS 76] ဟာ Appendix ရဲ့ [illegible] Figure [illegible] မှာ ပြထားတဲ့ graph ပေါ်မှာ ရှာရပါတယ်။ ဒီ graph ပေါ်မှာ earth fault current I_a = 294A ရဲ့ ဘေးဘက်ကနေ curve ကို ဖြတ်ပြီး ဘယ်ဘက်ကို ကြည့်ပါ။ ဒီလိုဆိုရင် fuse ကပျော်ဖို့ time ဟာ 0.4 second ဖြစ်ပါတယ်။

t = [illegible] ကပျော်ဖို့ time [0.4 second from the graph]

= 0.4 sec

အပိုင်း (ဆ) circuit ဟာ Regulation 543-01-01 နဲ့ကိုက်ညီသလား ဆိုတဲ့ adiabatic equation ကို သုံးပြီး စစ်ဆေးပုံ

ဒီ circuit ဟာ earth fault ဖြစ်တဲ့အခါ [illegible] ကပျော်ဖို့ time ဟာ [illegible] ဖြစ်ပါတယ်။

K = [illegible]

S = [illegible] = 70°C/pvc-insulated and [illegible] cable

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Example 4-2

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[redacted]

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[redacted]

Example 4-3

[redacted]

ဖြေရှင်းချက် (1) [redacted]

ဖြေရှင်းချက် (2) [redacted]

ဖြေရှင်းချက် (3) [redacted]

ဖြေရှင်းချက် (4) [redacted]

ဖြေရှင်းချက် (5) [redacted]

ဖြေရှင်းချက် (6) [redacted]

ဖြေရှင်းချက် (7) [redacted]

ဖြေရှင်းချက် (8) [redacted]

ဖြေရှင်းချက် (9) [redacted]

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ဥပမာ-(1) ... circuit ... power supply ... external earth fault loop impedance ...

Z_e = ... earth fault impedance ;

= 0.35 ohm (...)

ဥပမာ-(2) Table 54B ... Table 54C ... circuit ... Table ...

... cable ...

... Table 54C (...) ...

ဥပမာ-(3) ... earth fault loop impedance ... milliohms/m ...

... Table ... = (Table 54C (...)

R_1 = ... cable ... = 2mm² (...)

R_2 = ... cable ... = 2mm² (...)

R_2 = ... = 10mm² (...)

... 85°C ... thermoplastic ... cable ...

... (1.65) ... Table 2 ...

[R_1 (2mm²)+R_2 (10mm²)]m = ... mV/A/m = 22 milliohms/m

(R_1+R_2)m = ... mV/Am = 3.22 milliohms/m

ဥပမာ-(4) ... circuit ... earth fault loop impedance ... milliohms/m = ... ohm ...

R_1 + R_2 = $\frac{(R_1 + R_2)\,m}{1000}$ × ... cable ... m

(R_1+R_2)m = 3.22 milliohms/m (...)

l = 40m = ... cable ...

R_1 + R_2 = $\frac{3.22 \times 40}{1000}$ ohm

R_1 + R_2 = ... earth fault loop impedance = 0.129 ohm

ဥပမာ-(5) ... earth fault loop impedance ...

Z_e = ... earth fault loop impedance

= 0.35 ohm (...)

R_1+R_2 = ... earth fault loop impedance = 0.129 ohm (...)

Total earth fault loop impedance ...

Z_s = Z_e+(R_1+R_2)

= 0.35 + 0.129 = 0.479 ohm

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[redacted]

$$I_f = \frac{V}{Z_s} = \frac{230}{0.379} = 607\,A$$

[redacted]

[redacted]

[redacted]

$$I_f = 607\,A$$

[redacted]

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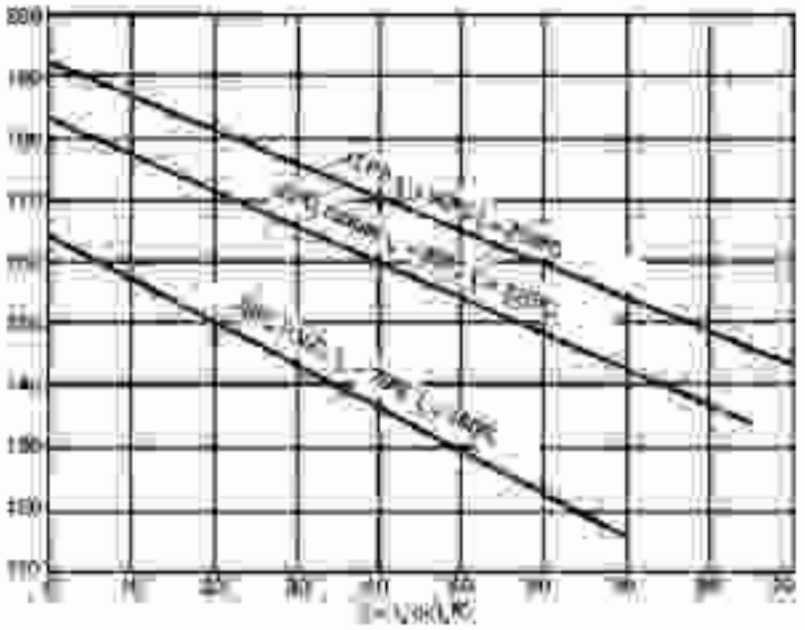

Figure 4.1 Variation of the constant K with initial temperature–copper conductivity

Table 4.1

where Table 54B applies, $\theta_i = 1$ or $2\,^{\circ}C$, for the epc and $\theta_i = 1$ or $2\,^{\circ}C$ for the bonded earth
Where Table 54C applies, $\theta_i = 1$ or $2\,^{\circ}C$ for both the epc and the conductor

Example 4.1

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[illegible] circuit [illegible] protective type [illegible]

[illegible]

I_n = 63A [illegible]

I_n = 32A – [illegible]

[illegible]

circuit [illegible] overload protection/ $I_n \geq 1.1 \times I_z$

circuit [illegible] overload protection/ short-circuit protection [illegible]

$I_n = I_z$

circuit [illegible] protective type-[illegible] overload နှင့် short-circuit protection

[illegible] circuit [illegible] overload protection [illegible]

$I_n = 1.1 \times 61A$

$= 63A$

[illegible] circuit [illegible] plane [illegible] I_z (tabulated current-carrying capacity) [illegible]

[illegible]

$I_z = \frac{I_n}{C_1 C_2 C_3 C_4}$ [illegible] Appendix 4 [illegible]

I_n = 63A [illegible]

C_1 (correction factor for ambient temperature) [illegible]

circuit [illegible] cable [illegible] = 70°C pvc-insulated and [illegible]

circuit [illegible] = I_a = 45°C (ambient temperature)

circuit [illegible] protective device [illegible] = BS 88 gG fuse

[illegible] Table4C1 [illegible]

C_1 = 0.79

C_2 (correction factor for grouping) [illegible]

circuit [illegible] cable [illegible] = three cable [illegible] [illegible]

[illegible]

C_2 = 1 [illegible] Appendix 4 [illegible]

C_3 (correction factor for thermal insulation)

circuit [illegible] cable [illegible] thermal insulating [illegible] [illegible]

[illegible]

C_3 = 1 [illegible] Appendix 4 [illegible]

C_4 (correction factor for type of protective)

circuit [illegible] protective device [illegible] = BS 88 gG fuse

[illegible]

C_4 = 1 [illegible] Appendix 4 [illegible]

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[illegible]

R_1 = [illegible]

R_2 = [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

$(R_1 + R_2)$ mΩ = [illegible]

[illegible]

$$R_1 + R_2 = \frac{[illegible] \times [illegible]}{1000} \text{ ohm}$$

$(R_1 + R_2)$/m = [illegible]

L = [illegible]

[illegible]

$$R_1 + R_2 = \frac{3.28 \times 35}{1000} = 0.115 \text{ ohm}$$

= [illegible]

[illegible]

Z_e = $Z_s - (R_1 - R_2)$ ohm

Z_s = [illegible]

Z_s = 0.5 ohm

$R_1 + R_2$ = 0.115 ohm

[illegible]

Z_e = $Z_s + (R_1 + R_2)$

= 0.5 + 0.115 = 0.615 ohm

[illegible]

[illegible]

$$\text{earth fault current} = \frac{\text{V (phase to neutral)}}{\text{earth fault loop impedance}} \text{ A}$$

V (phase to neutral) = 230 V

[illegible]

[illegible]

$$I_e = \frac{230}{0.615} = 282 \text{ A}$$

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Example 4-3

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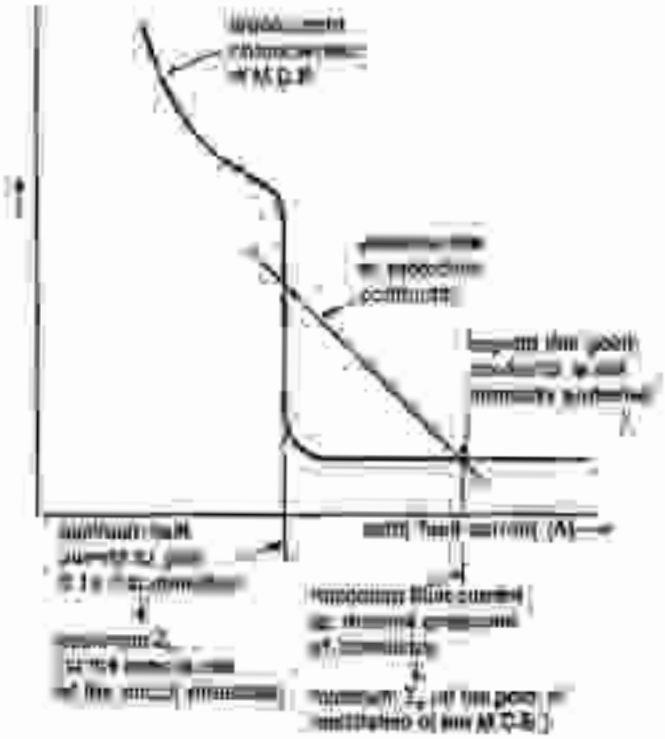

Figure 4.2 Relationship between switching characteristic, conductor admittance, and minimum hull maximum values for earth fault current measuring with loop impedance

Table 4.2 Minimum [illegible]

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Example 4.8

ဝန်ဆောင်မှု circuit အား လျှပ်စစ်ဓာတ်အားပေးကုမ္ပဏီ power supply circuit နှင့်ချိတ်ဆက်ပြီးနောက် external earth fault loop impedance ရှာဖွေခြင်း

ဝန်ဆောင်မှု Table 54B နှင့် Table 54C မှ circuit နှင့်ထပ်တူဖြစ်သော Table အား ရွေးချယ်ခြင်း

ဝန်ဆောင်မှု circuit ၏ earth fault loop impedance ရှာဖွေခြင်း

ဝန်ဆောင်မှု total earth fault loop impedance ရှာဖွေခြင်း

ဝန်ဆောင်မှု ကွက်လပ်ရှိသောအား circuit ၏ total earth fault loop impedance တန်ဖိုးသည် BS 7671 ၏ Table 41B2 မှ သတ်မှတ်ချက်နှင့်ကိုက်ညီခြင်းရှိမရှိ ကိုယ်တိုင်စမ်းသပ်ခြင်း

ဝန်ဆောင်မှု main ၏ earth fault loop impedance တန်ဖိုးနှင့် တွက်ချက်ရရှိသော each ၏ earth fault loop impedance တန်ဖိုးများနှင့် total earth fault loop impedance တန်ဖိုးများ ညီမျှခြင်း ရှိမရှိ

ဝန်ဆောင်မှု circuit ၏ fuse သင့်မြတ်မှုရှိမရှိ earth fault current စမ်းသပ်ခြင်း

ဝန်ဆောင်မှု earth fuse circuit အရ such ချွတ်ခြင်းတော်ကောင်းရှိမရှိ (disconnection time) ကို ရှာဖွေခြင်း

ဝန်ဆောင်မှု circuit earth ထိတွေ့ဆိုင်သည့် Regulation 543.1.1 နှင့် ကိုက်ညီမှုရှိ/မရှိ စစ်ဆေးခြင်း၊

ဝန်ဆောင်မှု circuit ဆောက်လုပ်ခြင်းတော်ကောင်းသည့် power supply circuit ချိတ်ဆက်ခြင်းမပြုမီ external earth fault loop impedance ရှာဖွေခြင်း

Z_e = circuit ဆောက်လုပ်ခြင်းတော်ကောင်းသည့် power supply circuit ချိတ်ဆက်ခြင်းမပြုမီ external earth fault loop impedance

= 0.35 ohm (ဖြစ်စေသောတန်ဖိုး)

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[illegible] Table 54B [illegible] Table 54C [illegible] Table 54C [illegible]

[illegible]

[illegible]

[

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...

...

...

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[illegible]

[illegible]

[illegible]

Example 6.7

[illegible]

[illegible]

[illegible]

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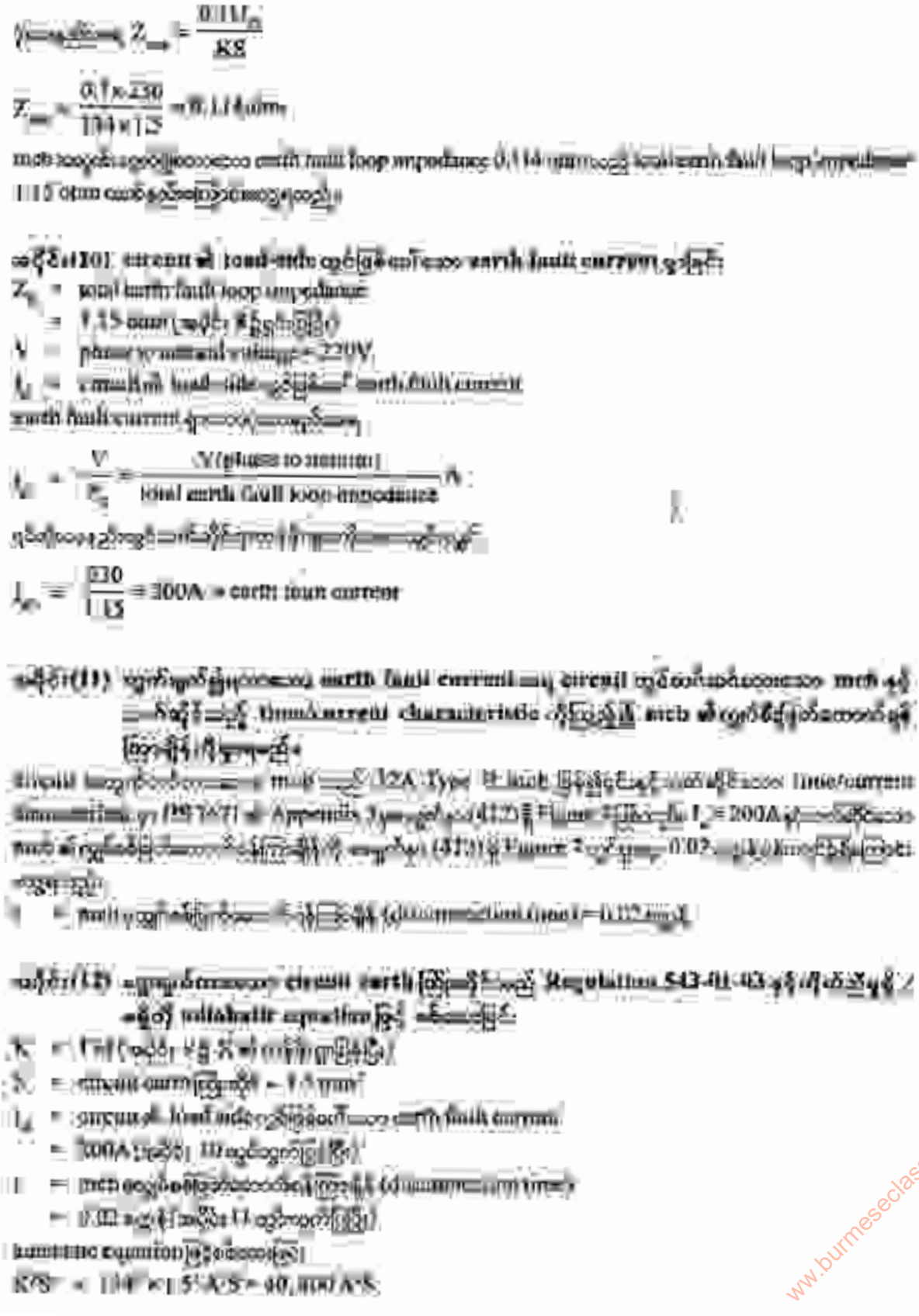

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ပြဿနာ (၄) circuit ၏ earth fault loop impedance တွက်ချက်ခြင်း

ပြဿနာ (၅) circuit earth ကြိုးကို ဖြုတ်လိုက်ခြင်း

ပြဿနာ (၆) ပုံတွင်ပြထားသော plug ကြိုးချိတ်ဆက်ထားသည့် circuit earth ကြိုးကိုဖြုတ်ပြီး circuit ၏ earth fault loop impedance တစ်ခုတိုင်းကို တိုင်းတာခြင်း

ပြဿနာ (၇) total earth fault loop impedance ရှာခြင်း

ပြဿနာ (၈) တွက်ချက်ရရှိသော total earth fault loop impedance တန်ဖိုးကို Table 41B2 ၏ အများဆုံးခွင့်ပြုထားသော earth fault loop impedance တန်ဖိုးများနှင့် နှိုင်းယှဉ်ခြင်း

ပြဿနာ (၉) circuit ၏ load side ရှိရာဆီသော earth fault current ရှာခြင်း

ပြဿနာ (၁၀) ရွေးချယ်ထားသော earth fault current နှင့် circuit တွင်တပ်ဆင်ထားသော overcurrent ကာကွယ်ရေးကိရိယာ ၏ ခွဲထုတ်ချိန် (disconnection time) ကိုရှာခြင်း

ပြဿနာ (၁၁) ရွေးချယ်ထားသော circuit earth ကြိုးကိုဖြုတ်ခြင်းဖြင့် Regulation 543-01-03 နှင့်ကိုက်ညီမှုရှိ/မရှိကို အဖြေထုတ်ခြင်း

ပြဿနာ (၁၂) အဝေးကွင်းဆက်ပိုင်းမှ earth fault loop impedance တန်ဖိုးကိုသိရှိခြင်းဖြင့် ကွင်းဆက်တစ်ခုလုံး၏ total earth fault loop impedance တန်ဖိုးကို ရှာဖွေခြင်း

ပြဿနာ (၁) circuit တစ်ခုတွင်ရှိစေလိုသော power supply circuit ဖြစ်သည့် transformer ကိုဖြုတ်ပြီး ကြိုးသုံးသပ်ထားသော external earth fault loop impedance ကိုရှာခြင်း

ပြဿနာ (၂) circuit တစ်ခုတွင် တပ်ဆင်ထားသော 20A Type C mcb ၏ အများဆုံးခွင့်ပြုထားသော earth fault loop impedance ကို BS 7671 ၏ Table 41B2 မှ ရှာခြင်း

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[illegible] Table 54B [illegible] Table 54C [illegible] circuit [illegible] Table [illegible]
[illegible] length of the circuit, [illegible] [illegible] transformer [illegible] secondary
[illegible] phase cable [illegible] conductor [illegible] [illegible] circuit [illegible] Table 54C [illegible]
[illegible]

[illegible] circuit [illegible] earth fault loop impedance [illegible]

Z_s = [illegible] [illegible] [illegible] [illegible] [illegible] external impedance [illegible] [illegible]
[illegible] [illegible] [illegible] earth fault loop impedance
= 0.05 ohm ([illegible])

Z_e = [illegible] secondary side [illegible] [illegible] earth fault loop impedance
= 0.275 ohm ([illegible])

$R_1 + R_2$ = [illegible] earth fault loop impedance

[illegible] earth fault loop impedance

$Z_s = Z_e + (R_1 + R_2)$

$R_1 + R_2 = Z_s - Z_e = 0.275 - 0.05 = 0.225$ ohm

$R_2 = R_1 = 0.225$ ohm

[illegible] earth fault loop impedance [illegible] [illegible] by [illegible] [illegible] [illegible]

[illegible] cable [illegible] 1.5 [illegible]

[illegible]

$$R_1 + R_2 \text{ m} = \frac{(R_1 + R_2) \times 1000}{\text{circuit length (metres)}} \text{ milliohms / m}$$

[illegible]

$$R_1 + R_2 \text{ m} = \frac{0.225 \times 1000}{15} = 15 \text{ milliohms/metre}$$

[illegible] circuit earth [illegible] [illegible]:

$(R_1 + R_2)$ m = 15 milliohms/m / [illegible] [illegible]

circuit earth [illegible] [illegible] Table 3.1A [illegible]

circuit [illegible] = 1 mm² [illegible]

[illegible] = 70°C [illegible]

[illegible] = Table [illegible] [illegible]

[illegible]

[illegible]

[illegible] = 2.5 mm²

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[illegible]

[illegible]

[illegible]

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$$I_e = \frac{V}{Z_e} = \frac{V_{(line-to-neutral)}}{\text{total earth fault loop impedance}} = \frac{230}{0.87} = 264\,A$$

I_e = circuit at load side of the earth fault current = 264 A

ဥပမာ(10) တွင်ဖော်ပြထားသည့် ရေတပ်သားသော earth fault current နှင့် circuit တွင်ထားရှိသော protective device ၏ operating time ကို အသုံးပြု၍ disconnection time ကိုရှာပုံ

ရေတပ်သားသော earth fault current = circuit တွင်ထားရှိသော protective device ၏ operating time ကို ကြည့်ရန်

ဥပမာ ၁၀ တွင် ကား၏ protective device ကို ရွေးချယ်ထားသော current သည် 200A ဖြစ်ပြီး type C circuit breaker ဖြစ်သောကြောင့် Time current characteristic ကို ကြည့်ပါက 0.1 second ခန့်တွင် trip ဖြစ်ကြောင်း တွေ့ရှိရမည်ဖြစ်သည်။ Figure 8 တွင်ပြထားသည့်အတိုင်း earth fault current I_e = 264A ရှိသောကြောင့် trip ဖြစ်ချိန်သည် 0.1 second ခန့်ဖြစ်ကြောင်း တွေ့ရှိရမည်ဖြစ်သည်။

ဥပမာ(11) အပူချိန်ထိန်းထားသော circuit earth တစ်ခုတွင် temperature 45°C ရှိသောကြောင့် ၎င်း၏ ခံနိုင်ရည်ကို ရှာပုံ

K ၏တန်ဖိုးများမှာ

circuit တွင်းရှိ conductor များ၏ initial temperature = 70°C (pvc insulated cable)

circuit တွင်ထားရှိသော conductor များတွင် အသုံးပြုထားသော material = copper

Table 54C အရ ကြည့်ရှုခြင်း (ဇယား 3 တွင်ရှိသည်)

ဇယား 54C = 401 (Table 54C)

K = 155

S = ရေတပ်သားသော circuit earth conductor = 4.5 mm² (အနီးစပ်ဆုံး ရွေးချယ်ပါ)

t = earth fault disconnection time = 0.1 second (ဥပမာ ၁၀ မှ ကြည့်ပါ)

I_e = circuit ၏ load side တွင်ဖြစ်ပေါ်သော earth fault current = 264A (ဥပမာ ၉ မှ ကြည့်ပါ)

substitute equation

$K^2S^2 = 155^2 \times 4.5^2 \quad K^2S^2 = 697.5^2$

$I^2t = 264^2 \times 0.1 \quad A^2S = 6,969.6\,A^2S$

$K^2S^2 > I^2t$

ထို့ကြောင့် ရေတပ်သားသော circuit earth conductor 4.5 mm² သည် temperature 45°C ရေနွေးတိုက်သည့်အခြေအနေတွင် earth fault current ကြောင့် ဖြစ်ပေါ်လာနိုင်သော

ဥပမာ(12) အပူချိန်ထိန်းထားသည့် earth ring loop impedance တန်ဖိုးများကို ရေတပ်သားသော total earth fault loop impedance နှင့် နှိုင်းယှဉ်ခြင်း

အထက်ဖော်ပြပါအတိုင်း earth ring loop impedance ကိုရှာပုံရှာနည်းမှာ

$$Z_{ring} = \frac{0.11\,\Omega}{2}$$

Z_{ring} = 0.055 Ω (ring ၏ တစ်ဝက်တန်ဖိုးကိုယူရသည်)

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V_{oc} = transformer secondary side ဘက် phase နှင့် neutral ကြား applied earth fault voltage
= 415V

I_a = [illegible]

$$Z_{ze} = \frac{0.1 \times 25}{115 \times 2.5} = 0.019 \text{ ohm}$$

[illegible] earth fault loop impedance သည် external earth fault loop impedance 0.05 ohm [illegible] circuit [illegible] total earth fault loop impedance [illegible] 0.069 ohm [illegible] total earth fault loop impedance [illegible]

RCCB (residual current-operated circuit breaker) [illegible] preferred rated voltage

single-phase, phase to neutral 230V

three-phase three wire 400V

three-phase four-wire 400V

preferred rated current (I_n)

10, 13, 16, 20, 25, 32, 40, 50, 63, 80, 100, 125 A

rated residual operating current ($I_{\Delta n}$)

0.006, 0.01, 0.03, 0.1, 0.3, 0.5A

standard value of residual non-operating current (I_{no})

$0.5 I_{\Delta n}$

minimum value of [illegible] making and breaking capacity

$10 I_n$ or 500A whichever is greater

rated conditional short-circuit current

The [illegible] short-circuit [illegible] the rated residual [illegible] and the [illegible] with and under the specific conditions

1, 1.5, 3, 4.5, 6, 10, 20, KA

maximum peak time

0.1 second for residual current equal to I_n

0.04 second for residual current equal to $2 I_n$

0.04 second for rated current equal to $5 I_n$

0.04 second for residual current equal to 500A

[illegible]

[illegible] shall be protected against short-circuit by means of circuit breakers or fuses

2- pole immediately intended to be operated by unmeasured persons and designed to be maintenance free

RCCB must [illegible] maximum breaking time [illegible] specified [illegible] equation

$K^2S^2 \geq I^2t$, $K = 0.04$, S

$$I_a = \frac{U_{oc}}{Z_s} A$$

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Example 4.9

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$$I_a = \frac{V}{Z_s} = \frac{230}{2.50} = 110A$$

I_a = circuit ရဲ့ load side တွင်ရှိသော earth loop current = 110A

ကြိုင်း(6) ဒဏ်ချက်မြေစနစ်ဖြင့် earth fault current သက်ဝင်ရန် ဓာတ်ခွဲခန်းတွင်တပ်ဆင်ထားသော
(disconnective time) ကိုရှာပါ။

I_a = ဓာတ်ခွဲခန်းတွင်တပ်ဆင်ထားသော earth fault current
= 110A (ကြိုင်းမှ ရရှိသောတန်ဖိုး)

I_m = ဓာတ်ခွဲခန်းတွင်တပ်ဆင်ထားသော current
= 100mA = 0.10A

I_a > I_m

earth fault current သက်ဝင်ရန် ဓာတ်ခွဲခန်းတွင်တပ်ဆင်ထားသော current ထက် 1100 ပိုများသောကြောင့်
ELCB ချွတ်ရန် လိုအပ်ပါသည်။

t = ELCB ချွတ်ရန်လိုအပ်သောအချိန်

= 0.04 စက္ကန့်

ကြိုင်း(7) circuit တွင် Regulation 543-01-03 နှင့်အညီ adiabatic equation ဖြင့်
ရှာပါ။

K တန်ဖိုးရှာခြင်း

circuit ကြိုးအမျိုးအစား Table = Table 54C (ကြိုင်း 2 နှင့်ကြည့်ပါ)

circuit ရဲ့ operating temperature = 70°C (pre-fault) = 160

circuit ရဲ့ ambient temperature = 30°C (Table 54C)

K = 115

S = circuit earth ကြိုးအရွယ် = 1.5mm² (ကျွန်တော်ရွေးသည်)

I_a = circuit ရဲ့ load side တွင်ရှိသော earth fault current

= 110A (ကြိုင်း 5 မှရရှိသည်)

t = earth fault ဖြစ်ပေါ်ချိန်မှ circuit ကို disconnect လုပ်ရန်လိုအပ်သော time

= 0.04 စက္ကန့်

adiabatic equation

$(KS)^2 = 115^2 \times 1.5^2 A^2 s = 29.756 A^2 s$

$I^2 t = 110^2 \times 0.04 = 484\ A^2 s$

$(KS)^2 > I^2 t$

ဖြစ်သောကြောင့် circuit သည် Regulation 543-01-03 နှင့်အညီ earth fault ကြာချိန်
ခံနိုင်ရည်ရှိပါသည်။

Example 4.10

A 400 V three-phase motor is supplied by a 3-core PVC insulated and PVC sheathed cable clipped to a perforated cable tray. The cable is protected by a BS 88 fuse. The motor has a full load current of 50 A. The cable is 20 m long. Determine the minimum cable size.

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[illegible]

[illegible]

[illegible]

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Example 4-11

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[redacted]

[redacted]

[redacted]

$$Z_s \leq \frac{0.2U_o}{KS}$$

[redacted]

$$Z_s \leq \frac{0.2U_o}{KS} = \frac{0.2 \times 230}{134 \times 1} = 0.32\ \text{ohm}$$

[redacted]

[redacted]

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[illegible]

[illegible]

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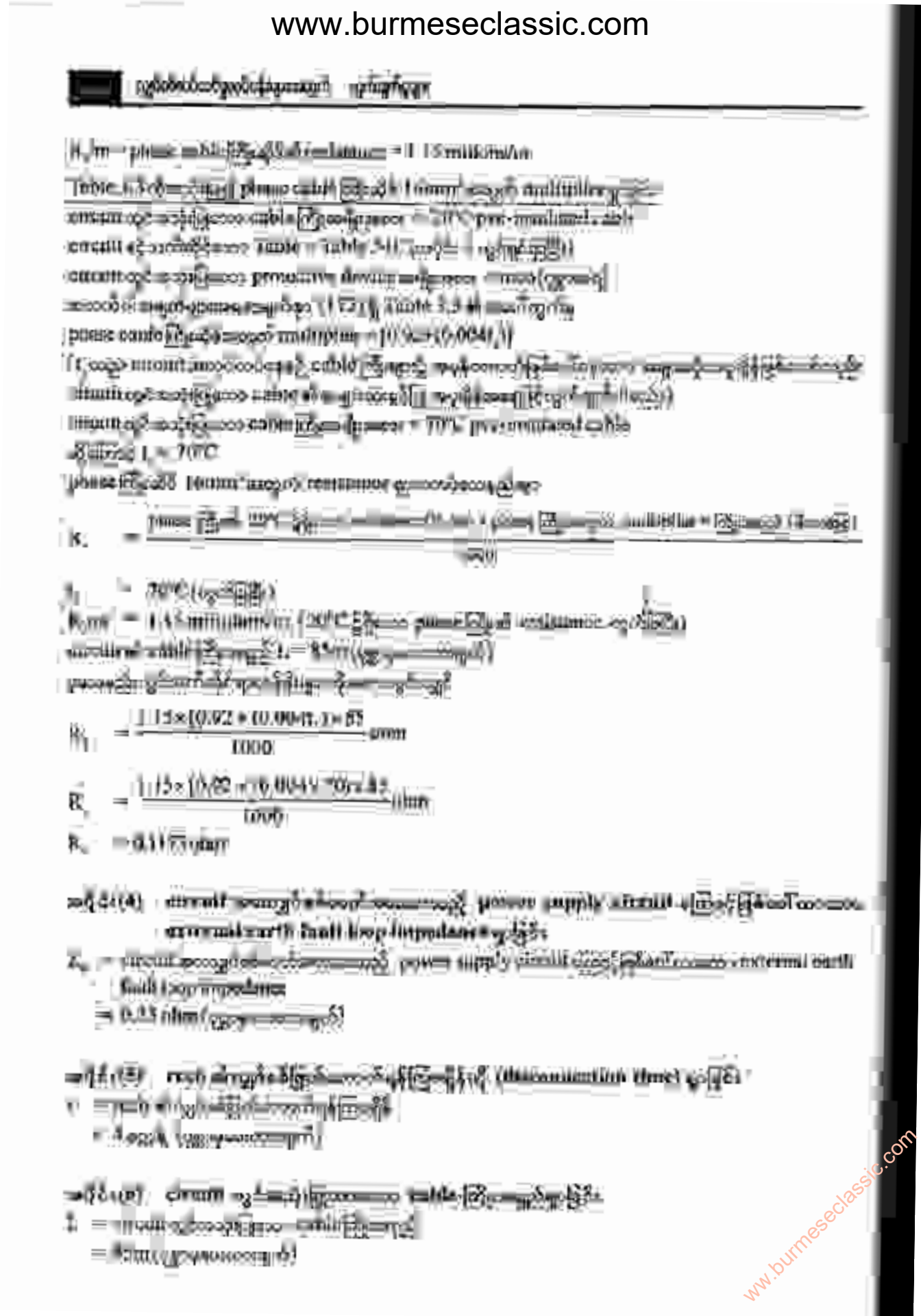

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[illegible] = 3.08 milliohms/m

[illegible] = 3.08 milliohms/m

[illegible]

$R_c + R_e = \frac{(R_1 + R_2)m}{1000}$ = [illegible]

[illegible]

[illegible] = 3.08 milliohms/m

$R_c + R_e$ = [illegible] = 0.45 ohm

[illegible]

Z_s = [illegible]

[illegible]

$R_c + R_e$ = [illegible]

= 0.45 ohm

Z_s = [illegible]

[illegible]

Z_s = $\sqrt{(R_c + R_e)^2 + (X)^2}$ = 0.78 ohm

Z_s = [illegible] = 0.78 ohm

[illegible]

$Z_s \times I_a \leq 50V$

[illegible]

Z_s = [illegible] = 0.78 ohm

I_a = [illegible] = 100mA = 0.1A

[illegible] = 0.78 × 0.1 = 0.78 ≤ 50V

[illegible]

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CHAPTER-5

CALCULATION RELATED TO SHORT CIRCUIT CONDITIONS

A.C.SINGLE-PHASE CIRCUITS

$$I_{sc} = \frac{V_s}{\sqrt{(R_s + R_{sc})^2 + (X_s + X_{sc})^2}} A = \frac{V_s}{Z_{sc}} A$$

Where R_s =

X_s =

R_{sc} =

X_{sc} =

Z_{sc} =

R_c =

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X_s = [illegible]
R_s = [illegible]
X_m = [illegible]
U_n = [illegible]

[illegible] R_s and R_m are at the normal temperature under cold condition but X_s and X_m are [illegible] R_s and R_m are at the rating operating temperature (for the type of insulation used for the apply circuit materials).

Note that in some case where there is no [illegible] where the [illegible] form a contactor [illegible] $(R_s + R_m)$ [illegible] $2R_s$.

[illegible] R_s, X_s, R_m and X_m are not know separately and only the prospective short circuit current I_{ps} of the origin of the installation is know, then this immediately gives the [illegible] impedance (Z_{ps}) also [illegible]

$$Z_{ps} = \frac{U_o}{I_{ps}} \text{ ohms}$$

where I_{ps} is the prospective short circuit current.

$$Z_{ps} = \sqrt{(R_s + R_m)^2 + (X_s + X_m)^2} \text{ ohms}$$

when only Z_{ps} is know the maximum earthing [illegible] of the circuit can be [illegible] by:

$$I_{sc} = \frac{U_o}{Z_{ps} + \sqrt{(R_1 + R_2)^2 + (X_1 + X_2)^2}} \text{ A} = \frac{U_o}{Z_{ps}} \text{ A}$$

When the [illegible] of the above is less than 35mm² then [illegible] and be ignored and the above equation becomes

$$I_{sc} = \frac{U_o}{Z_{ps} + R_1 + R_2} \text{ A} = \frac{U_o}{Z_{ps}} \text{ A}$$

[illegible] I_{sc} is also used to determine the [illegible] (I) from the time / current characteristic of the overcurrent protective device and to then check that this time is less than K^2S^2/I^2 seconds.

Table 5 [illegible] $(R_1 + R_2)$ [illegible] 35mm², enabling [illegible] and normal conditions will have the same cross-sectional area.

[illegible]
I_{sc} = [illegible] short-circuit current
Z_{ps} = [illegible] short-circuit impedance
U_o = [illegible]
X_s = [illegible]
R_m = [illegible]
X_m = [illegible]
$R_1 + R_2$ = [illegible]
Z_s = $Z_{ps} - (R_s + R_m)$ [illegible]

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Table 5.1 Values of (R_1+R_2) in the power conductor at their normal operating temperature in milliohms/metre.

Conductor size	Insulation material					
	PVC					
1						
1.5						
2.5						
4						
6						
10						
16						
25						
35						

The value of (R_1+R_2) in can be directly obtained from the appropriate column of the table in Appendix 4 of BS 7671.

$$(R_1+R_2)\ \text{in}\ \Omega/\text{km} = \text{resistance in}\ \Omega/\text{km} \times \left[\frac{234.5+t_1}{230+t_1}\right] \text{milliohms/m}$$

where t_1 °C is the assumed conductor temperature under short circuit condition and t_1 °C is the maximum permitted normal operating temperature of the type of insulation concerned.

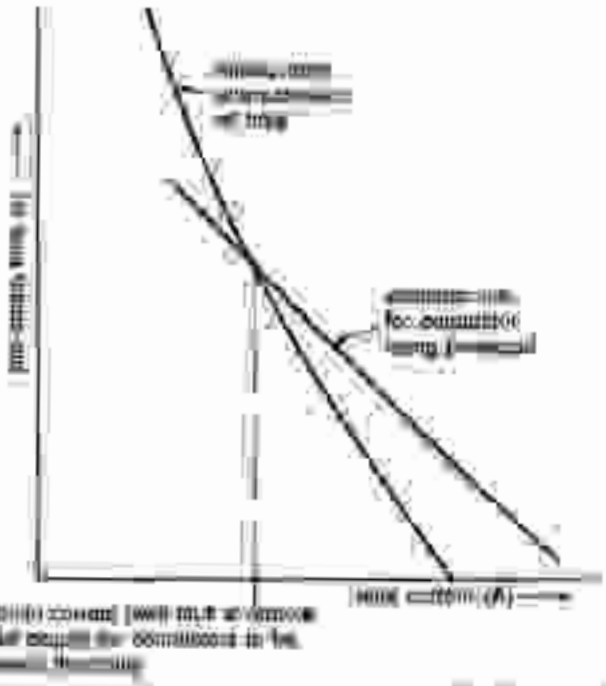

Fig. 5.1 Pre-fault current characteristics showing minimum limit curves for various rating of fuse conforming to the relevant BS specification.

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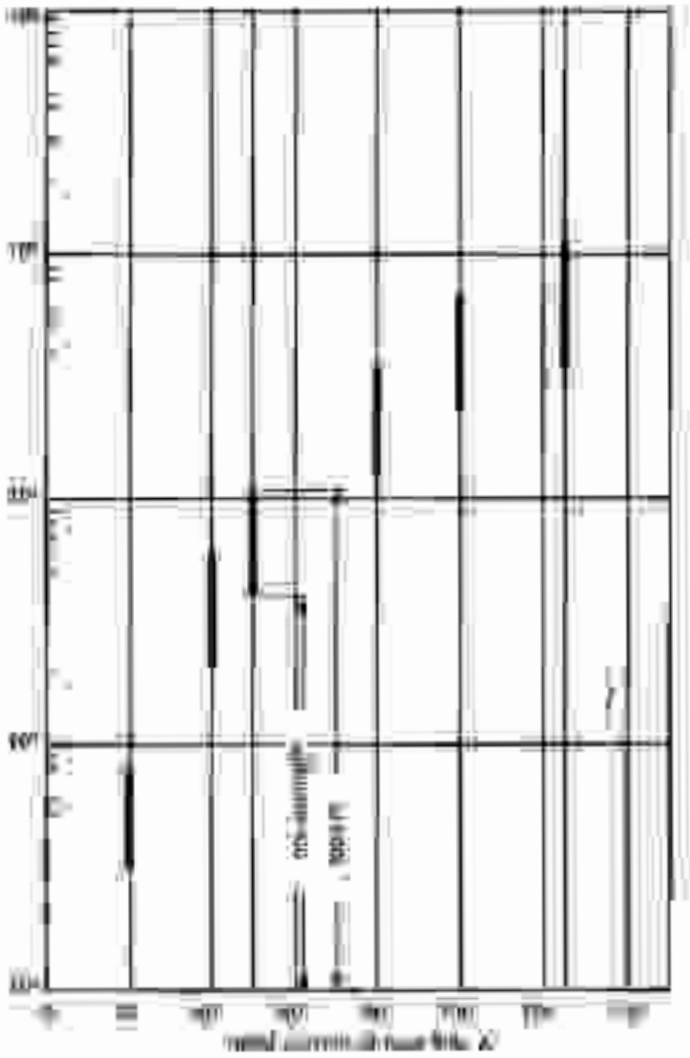

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[illegible]

ဥပမာ(၁) [illegible] power supply circuit တစ်ခုတွင်ဖြစ်ပေါ်သော short-circuit impedance များဖြစ်သော အစိတ်အပိုင်း circuit တွင်စီးဆင်းသော short-circuit impedance ရှာဖြေခြင်း။

ဥပမာ(၂) circuit၏ short-circuit impedance များကိုရှာဖြေခြင်း။

ဥပမာ(၃) [illegible] short-circuit impedance ရှာဖြေခြင်း။

ဥပမာ(၄) circuit၏ load side တွင်ရှိသော [illegible] natural short-circuit current ရှာဖြေခြင်း။

ဥပမာ(၅) တစ်ခုတည်းသော short-circuit current ကြောင့် circuit တွင် short-circuit ဖြစ်ပွားချိန် [illegible] ကြားဝင်ခြေပြတ်သောအချိန်ကို [illegible] (disconnection time) တို့ရှာဖြေခြင်း။

ဥပမာ(၆) circuit [illegible] Regulation 434-03-03 နှင့် ကိုက်ညီမှု ရှိ/မရှိ [illegible] equation ဖြင့်စစ်ဆေးခြင်း။

ဥပမာ(၁) ကျွန်ုပ်တို့ [illegible] power supply circuit တစ်ခုဖြစ်ပေါ်သော short-circuit impedance များကိုရှာဖြေခြင်း အစိတ်အပိုင်းတွင် [illegible] (external) short circuit impedance ရှာဖြေခြင်း။

I_{sc} = [illegible] power supply [illegible] short-circuit current

= [illegible] A

V = [illegible] nominal voltage = [illegible] V

Z_{sc} = [illegible] short-circuit impedance

[illegible] short-circuit impedance

$$\text{short-circuit impedance} = \frac{V}{I_{sc}\ (\text{[illegible]})}$$

$$Z_{sc} = \frac{V}{I_{sc}} = \frac{230}{3000}\ \text{ohm}$$

Z_{sc} = [illegible] ohm = circuit တွင် (external) short-circuit impedance

ဥပမာ(၂) circuit၏ short-circuit impedance များကို

R_1 = [illegible] [illegible] = [illegible] mm²

R_2 = [illegible] [illegible] = [illegible] mm²

[illegible] = [illegible] = [illegible] = [illegible] per [illegible] and [illegible]

= [illegible] = [illegible] [illegible] [illegible] [illegible]

[illegible] = [illegible] mV / A / m = [illegible] milliohm / m

$(R_1 + R_2)$ / m = [illegible] milliohm / m = circuit short-circuit impedance

ဘူတိုကြိုးအရှည် = circuit၏ impedance [illegible] milliohm / m ဖြစ်ပါသည်။

[illegible] = [illegible] [illegible] L = [illegible] (ရှာဖြေခြင်းအဆင့်)

$(R_1 + R_2)$ / m = 2.76 milliohm / m

= circuit ၏ short-circuit impedance

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Example 5-2

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[illegible] Eleventh [illegible] Regulation 434-05-03 [illegible] automatic equipment [illegible]

[illegible] sub-distribution board [illegible] power supply circuit [illegible] short-circuit impedance [illegible] circuit [illegible] (external) short-circuit impedance [illegible]

I_{ss} = sub-distribution board [illegible] power supply circuit [illegible] short-circuit current

= 2500A [illegible]

V_n = [illegible] to neutral voltage = 230V

Z_s = sub-distribution board [illegible] = [illegible] = short-circuit impedance

[illegible] impedance [illegible]

$$Z_{ss} = \frac{\text{Voltage to neutral}}{\text{Short circuit current}}$$

[illegible]

$$Z_{ss} = \frac{230}{2500} = 0.092\text{ohm}$$

[illegible] circuit short-circuit impedance [illegible]

R_1 = [illegible] = 2.5mΩ/m (0.0025Ω/m)

X_1 = reactance value [illegible] = 0.08mΩ/m (0.00008Ω/m)

circuit cable [illegible] = 0.0025Ω/m × 30m = 0.075mΩ measured value

[illegible] (1) [illegible] 3.1 [illegible]

$(R_1 \Omega/m \times 2) + (X_1 \Omega/m \times 2) = \text{value in } \Omega/m = 0.164\text{ milliohm/m}$

$R_1 + X_1 = 1.74\text{ milliohm/m}$ [illegible] short-circuit impedance

[illegible] circuit [illegible] impedance [illegible]

length [illegible] cable [illegible] = 17m

$(R_1 + X_1)/m$ = value in $\Omega/m = 1.74$ milliohm/m

[illegible]

$$R_1 + R_2 = \frac{1R_1 + R_2 \times 17m}{1000} = \text{circuit cable impedance}$$

[illegible] $1R_1 + R_2 = 0.0295\Omega$

$$R_1 + R_2 = \frac{0.74 \times 17}{1000} = 0.038\text{ohm} = \text{circuit short-circuit impedance}$$

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[redacted]

[redacted]

[redacted]

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Example-3-4

[redacted]

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...

...

...

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[illegible]

$$I_s = \frac{V(\text{phase to phase})}{\text{Total circuit impedance}} = \frac{V}{Z_s} A$$

[illegible]

$$I_s = \frac{110}{0.218} = 500A$$

[illegible]

[illegible]

[illegible]

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[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

The Mote Ragoom Method for A.C. Single-Phase Circuit

[illegible]

Example 5.6

[illegible]

ဖြေရှင်းနည်း

အဆင့် (1) [illegible]

အဆင့် (2) [illegible]

အဆင့် (3) [illegible]

အဆင့် (4) [illegible]

အဆင့် (5) [illegible]

အဆင့် (6) [illegible]

အဆင့် (7) [illegible]

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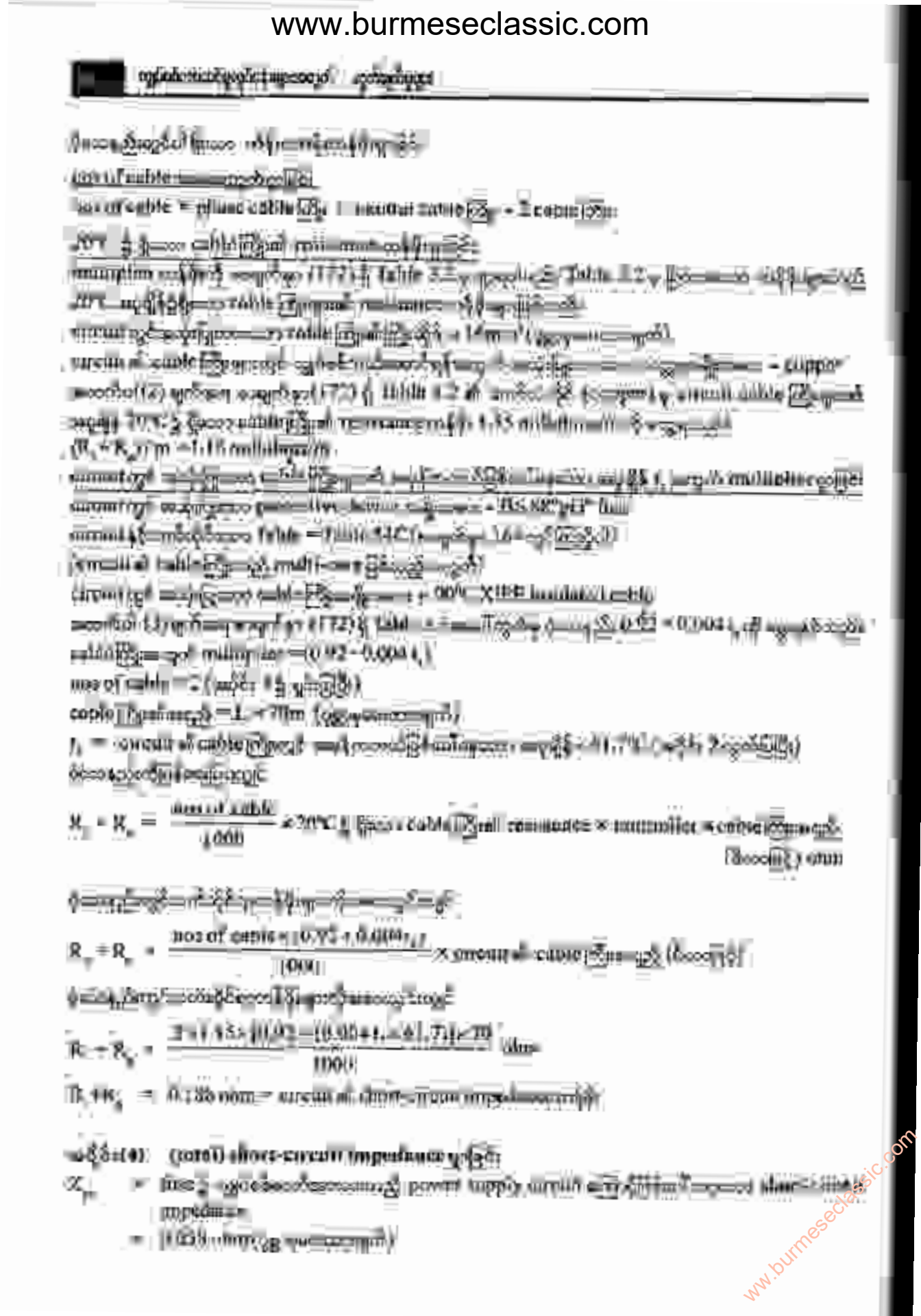

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$$I_s = \frac{V}{Z} = \frac{V \text{ (phase to neutral)}}{\text{total) short circuit current}} = \frac{230}{0.234} = 1075\text{A}$$

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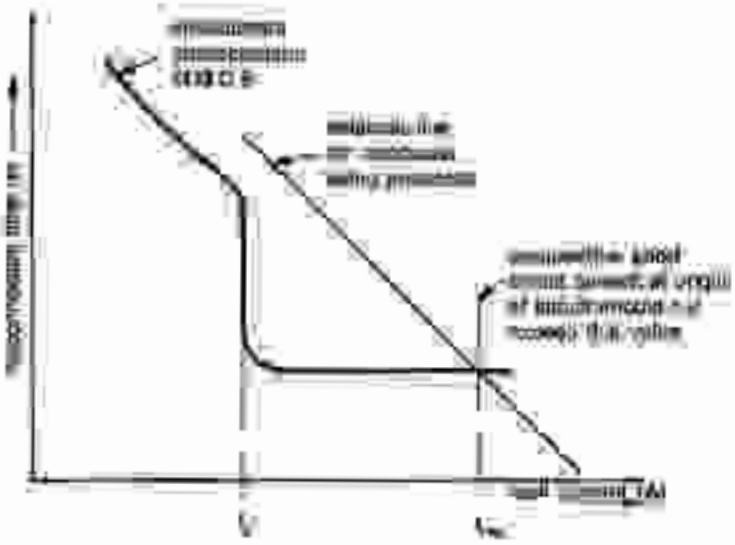

Note

If the prospective short-circuit current at the origin of the circuit does exceed I_{cs} reference should be made to the manufacturer of the M.C.B unless I_{cs} is the maximum breaking capacity of the M.C.B unless the second paragraph of Regulation 434-03-03 is invoked.

Figure 3.5 Relationship between circuit breaker time-current characteristic and conductor adiabatic heating constant (shown positive for copper conductor)

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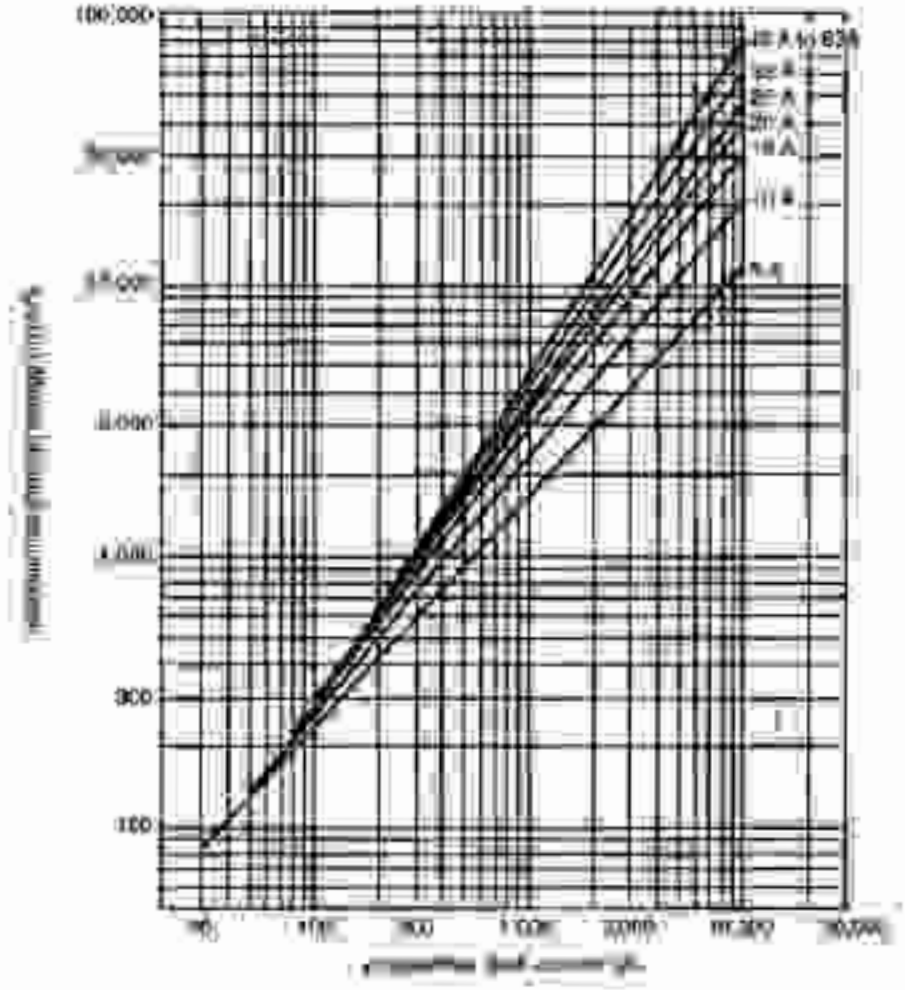

Figure 5.4 Typical let-through energy characteristics for Type B circuit-breakers with a breaking capacity of 10,000 A

Example 5.7

230 V single-phase circuit-breaker operating at 85°C ambient temperature and protecting a non-armoured cable [illegible] conductors [illegible] power supply circuit [illegible] short-circuit impedance Z_s = 0.028 ohm [illegible] cable [illegible] I = 35 mm [illegible] overload [illegible] 40 A Type B circuit-breaker [illegible]

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[illegible] short-circuit current [illegible] Regulation 434-03-03 [illegible]

[illegible] (3) [illegible]

(1) [illegible]

(2) [illegible] Regulation 434-03-03 [illegible]

(3) [illegible] short-circuit current [illegible]

(1) [illegible]

(1-1) [illegible]

(1-2) [illegible]

(1-3) [illegible]

(2) [illegible] Regulation 434-03-03 [illegible]

(2-1) [illegible]

(2-2) [illegible] Regulation 434-03-03 [illegible]

(3) [illegible] Regulation 434-03-03 [illegible]

(3-1) [illegible]

(3-2) [illegible]

(3-3) [illegible]

(3-4) [illegible]

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(5-5) short-circuit test ပြုစုသောအခါ အစီအဆင်အတွက် မည်သည့်အချက်အလက်များ short-circuit current ရှာ
current တွင် အဓိကပြဿနာတက်ရောက်နိုင်ကြောင်း ရှင်းပြပါ။

(5-6) current သည် Regulation 434-03-03 နှင့် ကိုက်ညီမှု ရှိ / မရှိ ဆုံးဖြတ်ရန် adiabatic equation ကြိုး
စီးသောအခါ (အစီအဆင် short-circuit ဖြစ်ပွားချိန် circuit ကြာချိန်, ယေဘုယျအားဖြင့်)

အပိုင်း (၂) ။ ။ breaking capacity ရှာဖွေခြင်း

(5-11 circuit ပတ်လမ်းအတွင်းသော mesh ၌ လျှပ်စီးစက်ကွင်းသည့် power supply circuit များကြောင့်
ဖြစ်ပေါ်သောအား short-circuit impedance ရှာဖွေခြင်း

Z_{sc} = circuit အတွင်း အဝင်ဆုံးသောအား mesh ၌ လျှပ်စီးစက်ကွင်းသည့် power supply circuit များကြောင့်
ဖြစ်ပေါ်သောအား short-circuit impedance

= 0.028 ohm (ခန့်မှန်းတွက်ချက်ရရှိ)

(5-2) circuit အတွင် အဝင်ဆုံးသောအား mesh ၌ လျှပ်စီးစက်ကွင်းသောသည့် power supply circuit
များကြောင့်ဖြစ်ပေါ်သောအား short-circuit current ရှာခြင်း

I_{sc} = circuit လျှပ်စီးစက်ကွင်းသောအား mesh ၌ လျှပ်စီးစက်ကွင်းသောသည့် power supply circuit များကြောင့် ဖြစ်ပေါ်
သော short-circuit current

V = phase-to-neutral voltage = 230V

Z_{sc} = circuit အတွင်းဆုံးသောအား mesh ၌ လျှပ်စီးစက်ကွင်းသောသည့် power supply circuit များကြောင့် ဖြစ်ပေါ်
သောအား short-circuit impedance

= 0.028 ohm (ခန့်မှန်းတွက်ချက်ရရှိ)

short-circuit current တွက်ချက်ပုံနည်းစနစ်

$$I_{sc} = \frac{V}{Z_{sc}} = \frac{\text{V (phase-to-neutral voltage)}}{\text{short-circuit impedance}} = \frac{230}{0.028} = 8214A$$

(5-3) circuit တွင် အဝင်ဆုံးအား mesh ၏ breaking capacity ရှာဖွေခြင်း

I_{sc} = circuit အတွင်း အဝင်ဆုံးသော mesh ၌ လျှပ်စီးစက်ကွင်းသောသည့် power supply circuit များကြောင့် ဖြစ်ပေါ်သော
short-circuit current = 8214A (ခန့်မှန်းတွက်ချက်ရရှိ)

ထုတ်လုပ်ရောင်းချသော short-circuit current = 8214A ဖြစ်သည့် circuit အတွင်း အဝင်ဆုံးအား mesh ၌ အသုံးပြုရန်
10kA Type mcb of breaking capacity > short-circuit current ဖြစ်သော်လည်း ထိုသို့ဖြင့် breaking capacity
10000A နှင့်သော Type B mcb ကို အသုံးပြုရပါသည်။

အပိုင်း (2) circuit တွင် အဝင်ဆုံးသောအား mesh ၌ လျှပ်စီးစက်ကွင်းသည့် power supply circuit
များကြောင့်ဖြစ်ပေါ်သော short-circuit current ကို circuit ၏ ကြာချိန်ကို ရှာ / စစ်ဆေးခြင်း
ရှာ သည့် Regulation 434-03-03 နှင့် ကိုက်ညီမှု ရှိ / မရှိ ဆုံးဖြတ်ခြင်း

(5-4) လျှပ်စီးကွင်းသောအား short-circuit current မှ (type of) thermal energy characteristic
ကိုရှာဖွေခြင်း I²t through energy (I²t) ရှာဖွေခြင်း

circuit အတွင်းသော mcb မှ 40A Type B ဖြစ်သော ကြောင့် လျှပ်စီးစက်ကွင်းသောအား short-circuit current
I_{sc} = 8214 A ဖြစ်သော mcb ၏ breaking capacity 10000 A ဖြစ်သောကြောင့် ကိုက်ညီပါသည်။

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I_{sc} = three-phase short-circuit current

U_p = phase to neutral voltage

R_{sc} = circuit resistance to the power supply [illegible]

X_{sc} = circuit reactance to the power supply [illegible]

R_c = circuit resistance [illegible]

X_c = circuit reactance [illegible]

three-phase short-circuit current [illegible]

(a) phase to phase short-circuit current [illegible]

$$I_{sc} = \frac{0.87 \times U_p}{\sqrt{(R_{sc} + R_c)^2 + (X_{sc} + X_c)^2}}$$

three-phase short-circuit current [illegible] phase to phase short-circuit current [illegible]

(b) phase to neutral short-circuit current [illegible]

$$I_{sc} = \frac{U_p}{\sqrt{(R_{sc} + R_w + R_c + R_n)^2 + (X_{sc} + X_w + X_c + X_n)^2}}$$

U_p = phase to neutral voltage

I_{sc} = [illegible] short-circuit current

R_{sc} = circuit [illegible] power supply [illegible] short-circuit [illegible] resistance

X_{sc} = circuit [illegible] power supply [illegible] short-circuit [illegible] reactance

R_w = circuit [illegible] power supply [illegible] short-circuit [illegible] resistance

X_w = circuit [illegible] power supply [illegible] short-circuit [illegible] reactance

R_c = circuit [illegible] phase [illegible] resistance

X_c = circuit [illegible] phase [illegible] reactance

R_n = circuit [illegible] neutral [illegible] resistance

X_n = circuit [illegible] neutral [illegible] reactance

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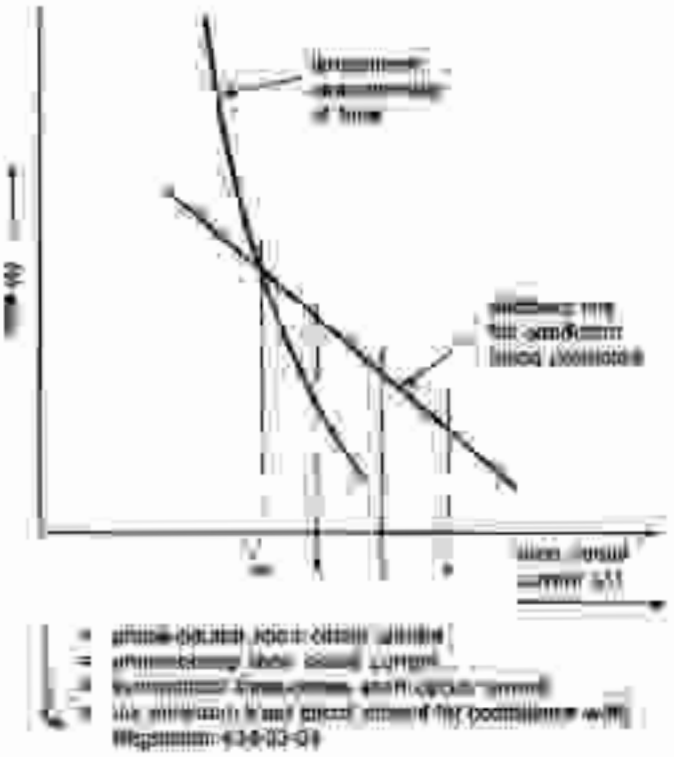

Figure 5.3 Relationship between fuse time / current characteristic, operation time and three-phase short circuit current.

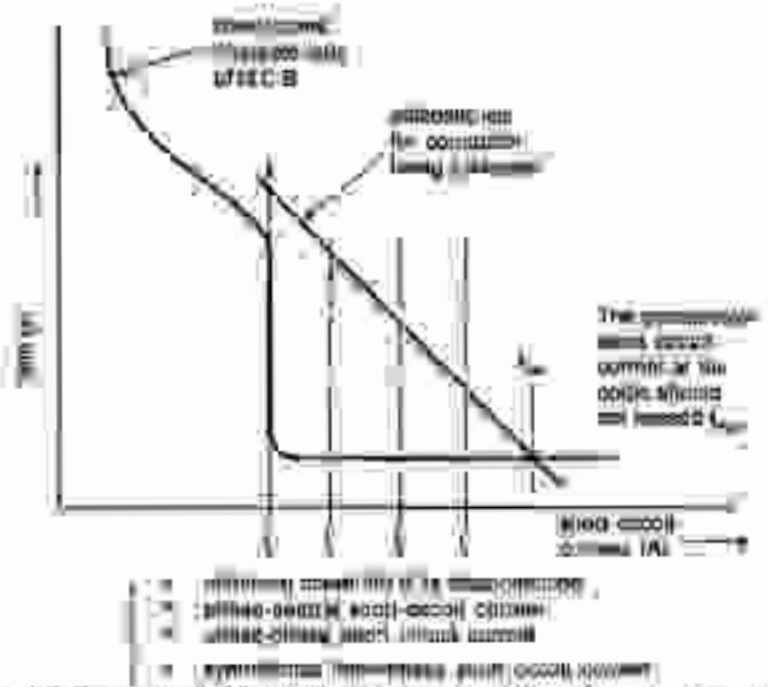

Figure 5.4 Relationship between fuse time / current characteristic, operation time and three-phase short circuit current.

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Example 5-8

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$$R_c + R_s = \frac{\text{no of conductor} \times \text{tabulated (mV/A/m)}}{\sqrt{3} \times 1000} \times \text{length of cable (m)}$$

Three-phase four-wire circuit ဖြစ်သောကြောင့် neutral conductor ပါဝင်ပါသည်။

$$X_c + X_s = \frac{\text{no of conductor} \times \text{tabulated (mV/A/m)}}{\sqrt{3} \times 1000} \times \text{length of cable (m)}$$

tabulated voltage drop ဆိုသည်မှာ rated current တစ်ampere နှင့် cable တစ်meter ရှည်သွားသည့်အခါ ဖြစ်ပေါ်သော voltage drop ကို mV ဖြင့် ဖော်ပြထားခြင်းဖြစ်သည်။

cable တစ်ခုတွင် conductor အရေအတွက် = 3 core, 3.5 core, 4 core, multi-core

cable တစ်ခု၏ conductor တစ်ခုချင်းစီ၏ cross-sectional area = 50mm²

cable တစ်ခု၏ conductor တစ်ခုချင်းစီ၏ cross-sectional area = 50mm² ရှိသော conductor တစ်ခု၏ resistance value = 0.86Ω/km

cable တစ်ခု၏ conductor တစ်ခုချင်းစီ၏ cross-sectional area = 50mm² ရှိသော conductor တစ်ခု၏ reactance value = 0.125Ω/km

three-phase circuit

three-phase four-wire circuit

cable တစ်ခု၏ conductor တစ်ခုချင်းစီ၏ cross-sectional area = 50mm² ရှိသော conductor တစ်ခု၏ resistance value = 0.86Ω/km

multi-core cable ဖြစ်သောကြောင့် [table 4E4B] မှ ရယူသုံးစွဲရမည်

circuit တစ်ခု၏ cable length = 60m

circuit တစ်ခု၏ cable length = 60m ရှိသော cable တစ်ခု၏ resistance voltage drop = 0.86 × 60 = 51.6mV/A

circuit တစ်ခု၏ cable length = 60m ရှိသော cable တစ်ခု၏ reactance voltage drop = 0.125 × 60 = 7.5mV/A

three-phase circuit ဖြစ်သောကြောင့် $\sqrt{3}$ ဖြင့် မြှောက်ရမည်

three-phase four-wire circuit ဖြစ်သောကြောင့် neutral conductor ပါဝင်ပါသည်။

$$R_c + R_n = \frac{\text{no of conductor} \times \text{tabulated (mV/A/m)}}{\sqrt{3} \times 1000} \times \text{length of cable (m)}$$

$$= \frac{2 \times 0.86 \times 60}{\sqrt{3} \times 1000} = 0.06\,\Omega$$

$$X_c + X_n = \frac{\text{no of conductor} \times \text{tabulated (mV/A/m)}}{\sqrt{3} \times 1000} \times \text{length of cable (m)}$$

$$= \frac{2 \times 0.125 \times 60}{\sqrt{3} \times 1000} = 0.0086\,\Omega$$

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[illegible]

$R_1 + R_2$ = [illegible] = 0.06 ohm

$X_1 + X_2$ = [illegible] = 0.0004 ohm

[illegible] (zero) short circuit impedance [illegible]

R_0 = [illegible]
= 0.035 ohm [illegible]

X_0 = [illegible]
= 0.05 ohm [illegible]

$R_1 + R_2$ = [illegible]
= 0.06 ohm [illegible]

$X_1 + X_2$ = [illegible]
= 0.0004 ohm [illegible]

Z_0 = [illegible]

[illegible]

$$Z_0 = \sqrt{[R_0 + (R_1 + R_2)]^2 + [X_0 + (X_1 + X_2)]^2}$$

[illegible]

$$Z_0 = \sqrt{(0.035 + 0.06)^2 + (0.05 + 0.004)^2}$$

$$= 0.112 \text{ ohm}$$

= [illegible]

[illegible] circuit [illegible] load side [illegible] phase to neutral short-circuit current [illegible]

Z_0 = [illegible]
= 0.112 ohm [illegible]

V = phase to neutral voltage = 230V

I_0 = [illegible]

[illegible]

$$I_0 = \frac{V}{Z_0} = \frac{\text{V(phase to neutral)}}{\text{[illegible]}} = \frac{230}{0.112} = 2053\text{A}$$

[illegible]

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[illegible]

[illegible]

[illegible]

[illegible]

Example 5-9

[illegible]

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ဇယား(၃) circuit ၏ short-circuit impedance များကိုရှာခြင်း

ဇယား(၃) total short-circuit current များကိုရှာခြင်း

ဇယား(၄) circuit ၏ load side ဆုံးဝိုင်းသောနေရာ phase to phase short circuit current များကိုရှာခြင်း

ဇယား(၅) ရလာတဲ့ဆုံးဝိုင်းသောနေရာ phase to phase short-circuit current နဲ့ circuit ကဆုံးဝိုင်းသောနေရာ line နဲ့ ချိတ်ဆက်ပြီးကာကွယ်ထားတဲ့ (the protection line) ကိုရှာခြင်း

ဇယား(၆) circuit သည် Regulation 434.03-03 နှင့် ကိုက်ညီမှု ရှိ / မရှိ ဆိုတဲ့ဇယားကိုဖြည့်စွက်ခြင်း

ဇယား(၁) sub-distribution board ရဲ့ ဆုံးဝိုင်းသောနေရာကို power supply circuit ကိုရှာဖို့ ဖြစ်ပါတယ်။ short-circuit impedance များကိုရှာခြင်း

I_{sc} = ဆုံးဝိုင်းသောနေရာ ဖြစ်ပေါ်နိုင်တဲ့ power supply circuit ကြိုးတွေကနေ ဆုံးဝိုင်းသောနေရာ circuit ကိုစီးဆင်းသွားမယ့် short-circuit current

= 14000A (အများဆုံးတန်ဖိုး)

V = nominal voltage = 230V

Z_{sc} = sub-distribution board ရဲ့ ဆုံးဝိုင်းသောနေရာတွေကနေ power supply source ကြားရှိ ပြောင်းလဲမှုမရှိသော impedance

ဖော်မြူလာကိုအသုံးပြုတွက်ချက်ခြင်း

$$Z_{sc} = \frac{V}{I_{sc}} = \frac{\text{V (ဆုံးဝိုင်းသောနေရာ circuit ကြားရှိ ပြောင်းလဲမှုမရှိသော short circuit current)}}{\text{ဆုံးဝိုင်းသောနေရာ circuit ကြားရှိ ပြောင်းလဲမှုမရှိသော short circuit current}} = \frac{230}{14,000} = 0.016 \text{ ohm}$$

ဇယား(၂) circuit ၏ short-circuit impedance ရှာခြင်း

ပေးထားသည့်အမျိုးအစား cable ဖြစ်သည့် 10mm² သတ်မှတ်ချက် 10mm² အတိုင်းသည် CBS 7671 အရပြောင်းလဲသွားသည့် impedance တန်ဖိုးများနှင့် ကွဲပြားမည်။ ထိုကြောင့် circuit ၏ impedance ဖော်ထုတ်ရာတွင် အသုံးပြုရမည့် BS 7671 ၏ Table 9A ကို ကြည့်ပါ။

circuit ရဲ့ ပုံစံအမျိုးအစား = 70°C thermosetting armoured cable

ကြိုးတန်းရဲ့ ကြိုးအရွယ်အစား = 10mm² (ကြေးနီကြိုး)

ဇယား 9A (ကြေးနီကြိုး) BS 7671 ၏ Table 9A ကိုကြည့်ပါ

(R1+R2)/m = ဇယား (10mm² ရဲ့ R1 + 10mm² ရဲ့ R2) / m

= 4.39 milliohms/m

= circuit ရဲ့ short-circuit impedance

ဆက်စပ်ဝါယာကြိုးအရွယ်အစား ကြေးနီကြိုးအတွက် ဖြစ်ပါတယ်။ ထိုကြောင့်

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[illegible]

Example 5.10

[illegible]

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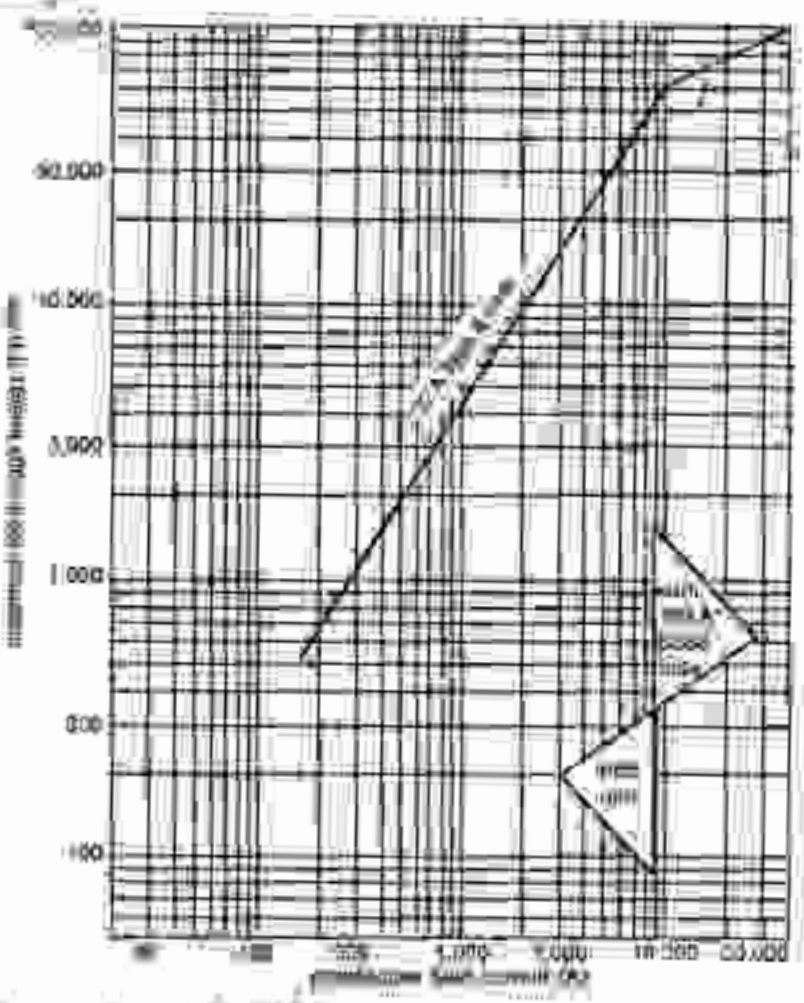

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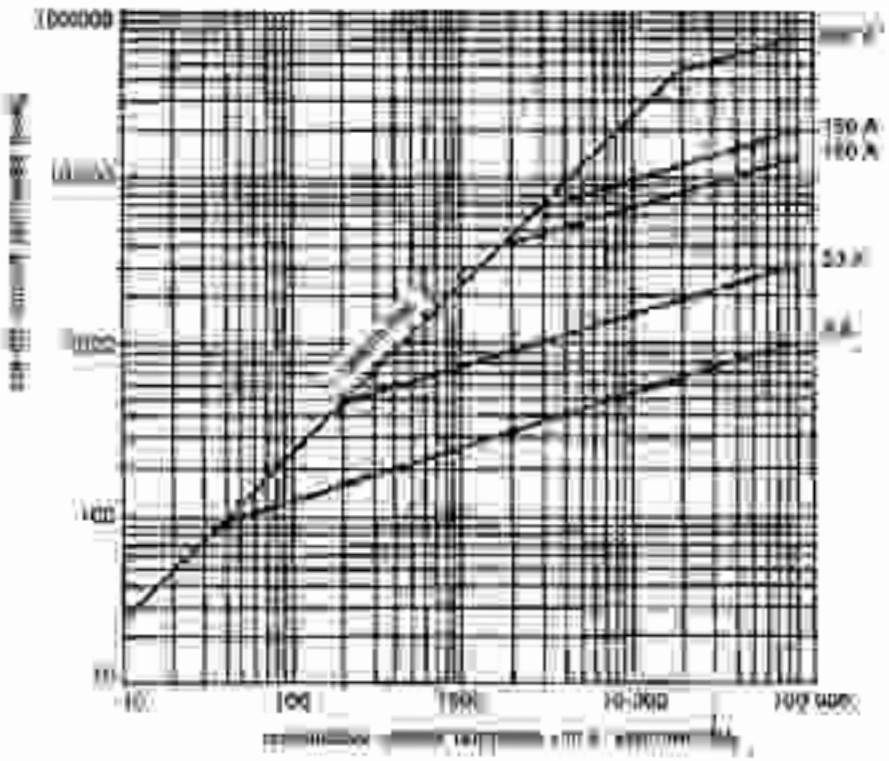

Note: The ... curve indicates the value of prospective current below which the ... operation is expected within the time stated on the datum line.

Figure 5.8 Typical cut-off current characteristics for BS 88 fuses

Table 5.2 Factors for minimum value of short-circuit breaking capacity

Rated breaking capacity (kA)			Factor
4.5	<	6	1.0
6	≤	10	1.2
10	≤	16	1.0
16	<	20	0.7
20	≤	50	0.5
50	<		0.4

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Example 5-11

[redacted]

ဥပမာ

[redacted]

ဖြေရှင်းချက်

[redacted]

(1) [redacted]

(2) [redacted]

(3) [redacted]

(4) [redacted]

(5) [redacted]

(6) [redacted]

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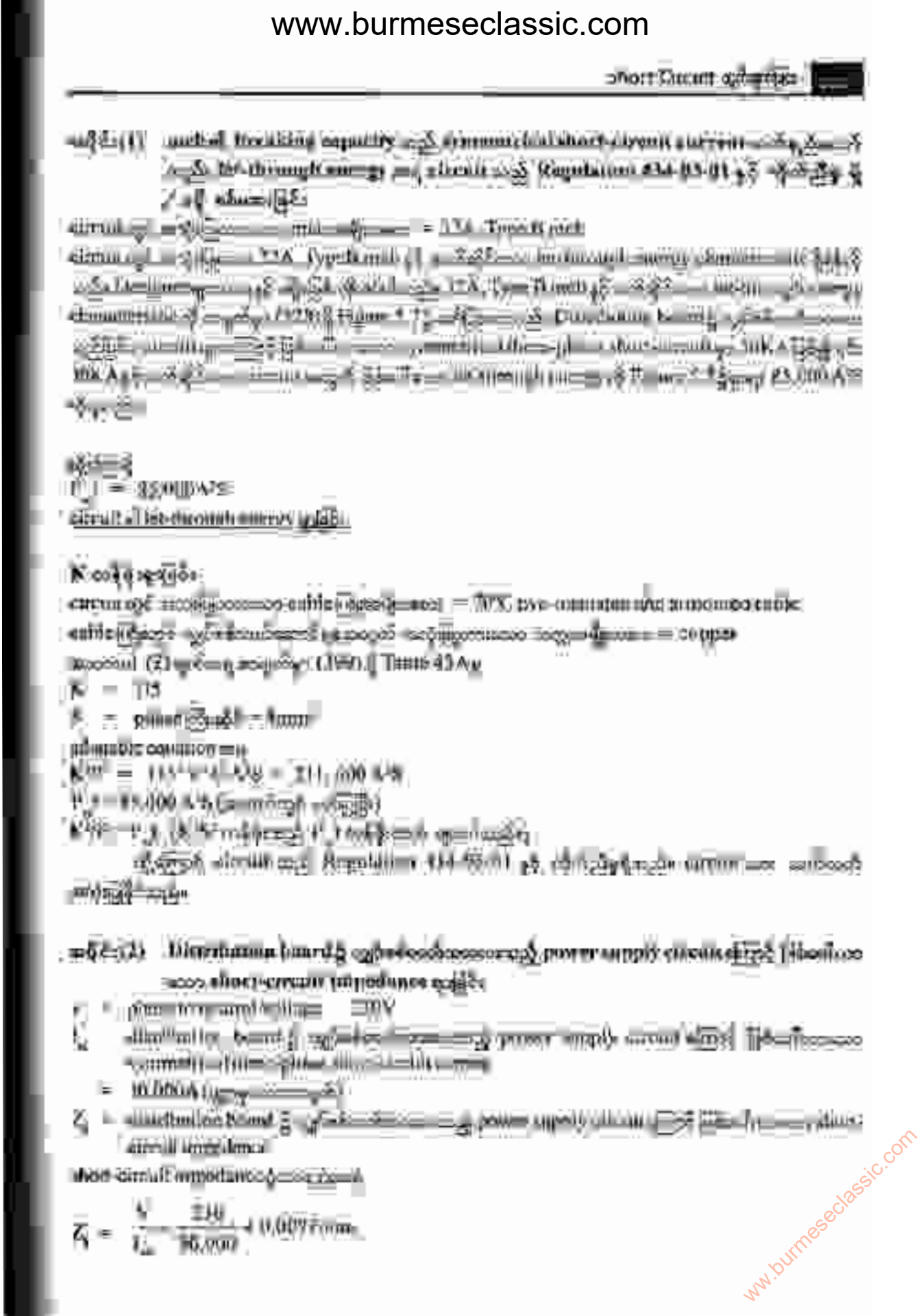

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[illegible] circuit ရဲ့ short-circuit impedance ရှာပုံ

[illegible]

[illegible]

[illegible]

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CHAPTER 6

Combined Examples

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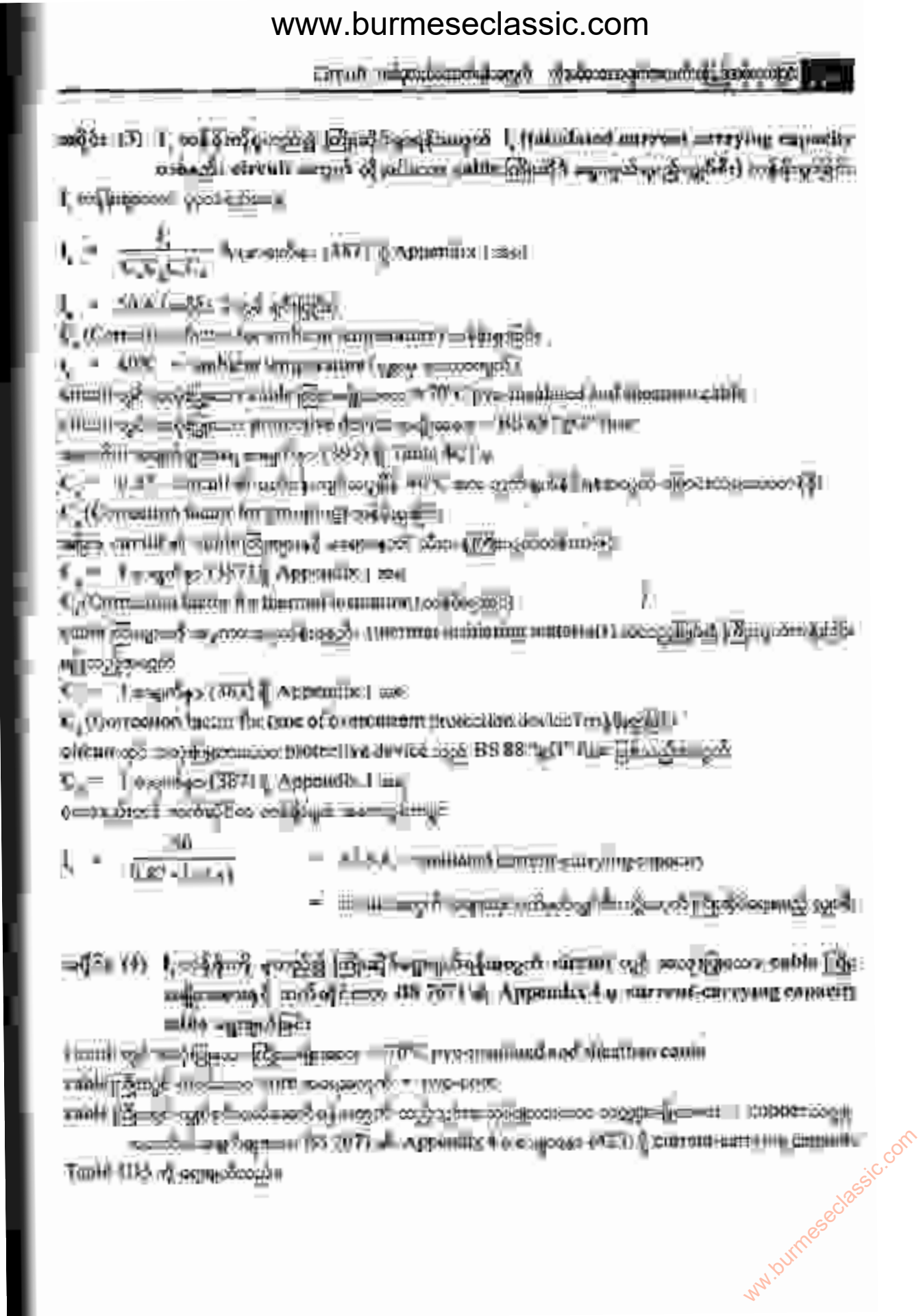

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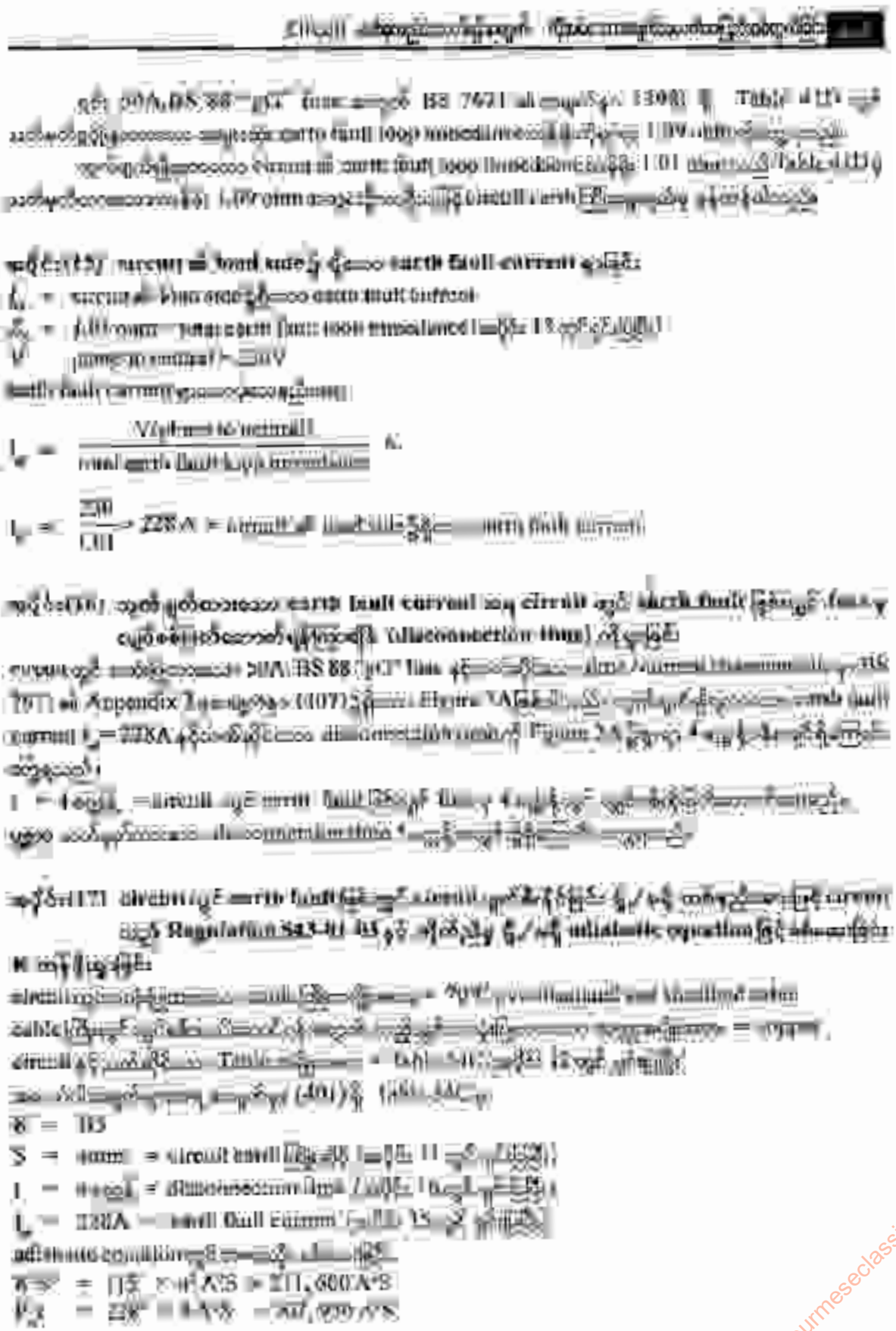

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[illegible]

[illegible]

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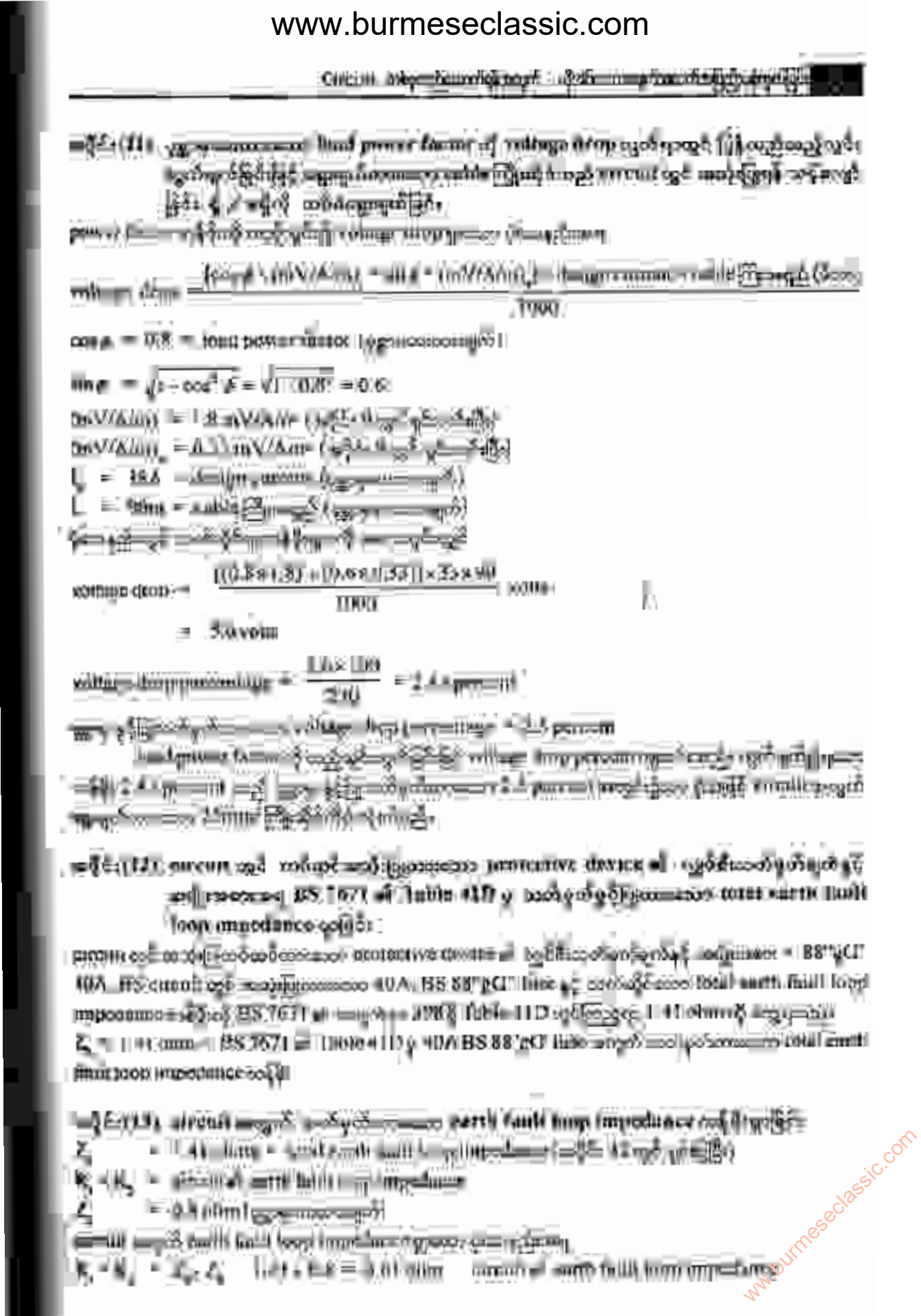

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[illegible]

$$[illegible] = \frac{[illegible] \times 100}{[illegible]} \text{ milliohm/m}$$

[illegible]

[illegible]

$$[illegible] = \frac{[illegible]}{90} = [illegible]$$

[illegible]

[illegible]

[illegible]

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[illegible]

$$R_x \parallel R_y = \frac{[R_x \parallel R_y] \text{ m} \times [\text{illegible}]}{[\text{illegible}]} \text{ ohm}$$

[illegible]

$$R_x \parallel R_y = \frac{0.402 \times 90}{100} \text{ ohm}$$

$R_x \parallel R_y$ = 0.38 ohm = [illegible] earth fault loop impedance

[illegible]

Z_e = 0.8 = [illegible] earth fault loop impedance

= [illegible]

$R_x \parallel R_y$ = 0.38 ohm [illegible] total earth fault loop impedance [illegible]

R_2 = [illegible]

[illegible]

Z_e = R_1 + ($R_x \parallel R_y$)

Z_e = [illegible] + 0.38 = [illegible] ohm = total earth fault loop impedance

[illegible]

earth fault current I_f = [illegible]

$$I_f = \frac{\text{V (phase to neutral)}}{\text{total earth fault loop impedance}} = \frac{V}{Z_e} \text{ A}$$

V = 230V [illegible]

Z_e = 1.18 ohm = total earth fault loop impedance = [illegible]

I_f = [illegible]

[illegible]

I_m = $\frac{230}{1.18}$ = 167A = [illegible]

[illegible]

[illegible] (disconnection time) [illegible]

[illegible]

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Example 6-3

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[illegible]

ဆိုင်း(1) [illegible]

ဆိုင်း(2) [illegible]

ဆိုင်း(3) [illegible]

ဆိုင်း(4) [illegible]

ဆိုင်း(5) [illegible]

ဆိုင်း(6) [illegible]

ဆိုင်း(7) [illegible]

ဆိုင်း(8) [illegible]

ဆိုင်း(9) [illegible]

ဆိုင်း(10) [illegible]

ဆိုင်း(11) [illegible]

ဆိုင်း(12) circuit [illegible] earth fault loop impedance [illegible]

ဆိုင်း(13) circuit earth [illegible]

ဆိုင်း(14) circuit [illegible] earth fault loop impedance [illegible]

ဆိုင်း(15) total earth fault loop impedance [illegible]

ဆိုင်း(16) circuit [illegible] earth fault current [illegible]

ဆိုင်း(17) circuit [illegible] earth fault [illegible] disconnection time [illegible]

ဆိုင်း(18) circuit [illegible] Regulation 543-01-03 [illegible]

ဆိုင်း(19) [illegible] circuit earth [illegible] Regulation 543-01-03 [illegible]

ဆိုင်း(20) circuit ဆိ earth fault loop impedance [illegible]

ဆိုင်း(21) total earth fault loop impedance [illegible]

ဆိုင်း(22) circuit ဆိ fault [illegible] earth fault current [illegible]

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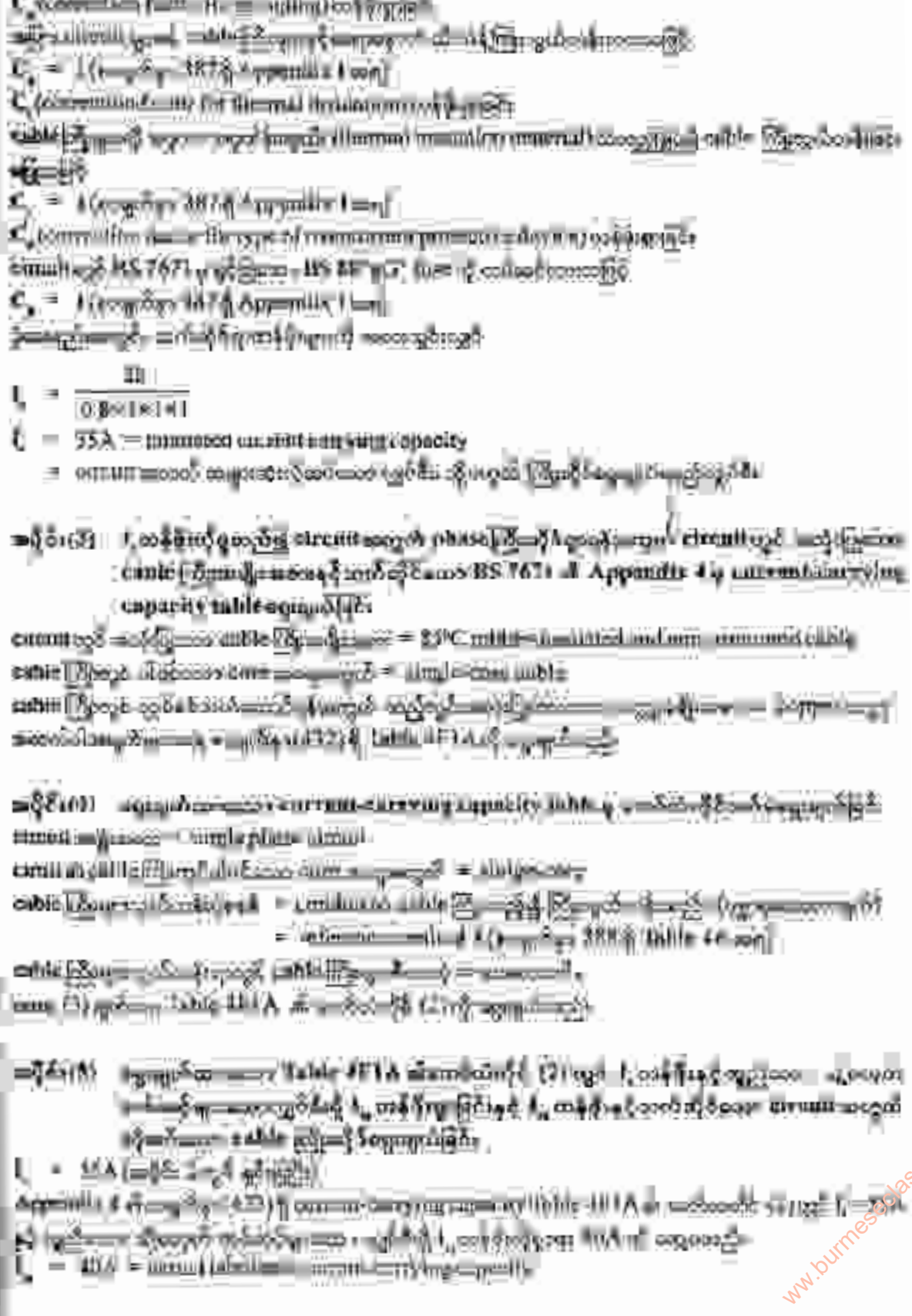

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$$R_1 + R_2 = \frac{11.5 \times 24}{1000} = 0.278 \text{ ohm} = \text{circuit earth fault loop impedance}$$

ပုံစံ(21) total earth fault loop impedance ရှာပုံ

Z_e = 0.35 ohm = external earth fault loop impedance (ပေးထားသော ဂဏန်း)

$R_1 + R_2$ = 0.278 ohm = circuit's earth fault loop impedance (ပုံစံ(20) မှ ရလာသော ဂဏန်း)

Z_s = total earth fault loop impedance

total earth fault loop impedance ကိုတွက်ပုံ

$Z_s = Z_e + (R_1 + R_2) = 0.35 + 0.278 = 0.628$ ohm

ပုံစံ(22) circuit ဆီတွေ့မည့် ဖြစ်နိုင်သော earth fault current ရှာပုံ

Z_s = 0.628 ohm = total earth fault loop impedance current (ပုံစံ 21 မှ ရလာသော ဂဏန်း)

V = 230V = phase-to-neutral

I_e = earth fault current

earth fault current ကိုတွက်ပုံ

$$I_e = \frac{V}{Z_s} = \frac{\text{V(phase-to-neutral)}}{\text{total earth fault loop impedance}} = \frac{230}{0.628} = 366A$$

I_e = 366A = circuit ဆီတွင် ဖြစ်နိုင်သော earth fault current

ပုံစံ(23) ဖော်ပြပါဇယားတွင် earth fault current တန်ဖိုးသည် time current characteristics ကွေးကွေးပေါ်ရှိ line မှ ထွက်ပေါက်သောအချက်မှ ကွေးကွေးကို (disconnection time) ရှာပုံ

I_e = 366A = earth fault current (ပုံစံ 22 မှ ရလာသော ဂဏန်း)

earth fault current = fuse မှ ထွက်ပေါက်သောအချက်မှ ကွေးကွေးကို ရှာပုံ။ current-operated protective device ကို ကြိုးဝိုင်းဆုံးဖြတ်ရာတွင် time current characteristics ကွေးကွေးကို ဖော်ပြထားသော SDA, BS 88 'C' fuse ကို အသုံးပြုသည်။ BS 1362 Appendix 3 ပုံစံ 417 Figure 3A တွင် earth fault current I_e = 366A ကို ဆွဲထားသော ဒေါင်လိုက်လိုင်း Figure 3A တွင် 0.4 စက္ကန့် ဖြတ်သွားသော အလျားလိုက်လိုင်း

ထို့ကြောင့်

I = 0.4 sec = fuse မှ ထွက်ပေါက်သောအချက်မှ ကွေးကွေးကို ရှာပုံ (disconnection time)

ပုံစံ(24) circuit ဆီတွင် Regulation 543-01-03 နှင့် ကိုက်ညီမှု ရှိ/မရှိ ကိုဆုံးဖြတ်ပုံ

K = 166 (ပုံစံ 18 မှ K ကို ရှာပုံ)

S = 2.5mm² = circuit earth ကြိုးရဲ့ cross-sectional area (ပုံစံ 19 မှ circuit earth ကြိုးရဲ့ ဖော်ပြထားသော ဂဏန်း)

I_e = 366A = earth fault current (ပုံစံ 22 မှ ရလာသော ဂဏန်း)

t = 0.4 sec = fuse မှ ထွက်ပေါက်သောအချက်မှ ကွေးကွေးကို ရှာပုံ (ပုံစံ 23 မှ ရလာသော ဂဏန်း)

adiabatic equation

K^2S^2 = (166)² × (2.5)² = 27556 × 6.25 = 172225

I_e^2t = (366)² × 0.4 = 133956 × 0.4 = 53582.4

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...

...(25) circuit ... power supply circuit ...
(external) short-circuit impedance ...:

I_{sc} (DB) = 4000A = (normal) short-circuit current (...)
V = 230V = ... normal
Z_{sc} (DB) = (external) short-circuit impedance
short-circuit impedance = ... (...)

$$Z_{sc} = \frac{V}{I_{sc}} = \frac{\text{V (phase to neutral)}}{\text{(external) short circuit current}} = \frac{230}{4000} = 0.0575\,\text{ohm}$$

Z_{sc} = ...
= DB (...) ... circuit ... ... circuit ... power supply circuit ... short-circuit impedance

...(26) circuit short-circuit impedance ...:
R_c = ... = ... (... ... ...)
R_c = ... = ... (...)
circuit ... = ... = 85°C rubber-insulated and non-armoured cable
... = ... 385 ... Table 5 I ... ...
$[R_1(6\text{mm}^2) + R_c(6\text{mm}^2)]$ (...) = 7.76 milliohms/m
$(R_1 + R_c)/1000$ = 7.76 milliohms = circuit ... short-circuit impedance
circuit ... short-circuit impedance ... milliohms/m ... ...
...

$$R_1 + R_c = \frac{(R_1 + R_c)\text{/m} \times \text{circuit} \ldots \text{table} \ldots (\text{m})}{1000}\ \text{ohm}$$

$(R_1 + R_c)$/m = 7.76 milliohms/m (...)
L = 24m = circuit ... cable ... (...)
... ...

$$R_1 + R_c = \frac{7.76 \times 24}{1000} = 0.186\,\text{ohm} = \text{circuit ... short-circuit impedance}$$

...(27) (total) short-circuit impedance ...:
$X_c + R_c$ = 0.185 ohm = ... short-circuit impedance (... ...)
Z_{sc} = 0.0575 ohm + ... = ... power supply circuit ... ...
... (total) short-circuit impedance (... ... ...)
Z_{sc} = (...) short-circuit impedance

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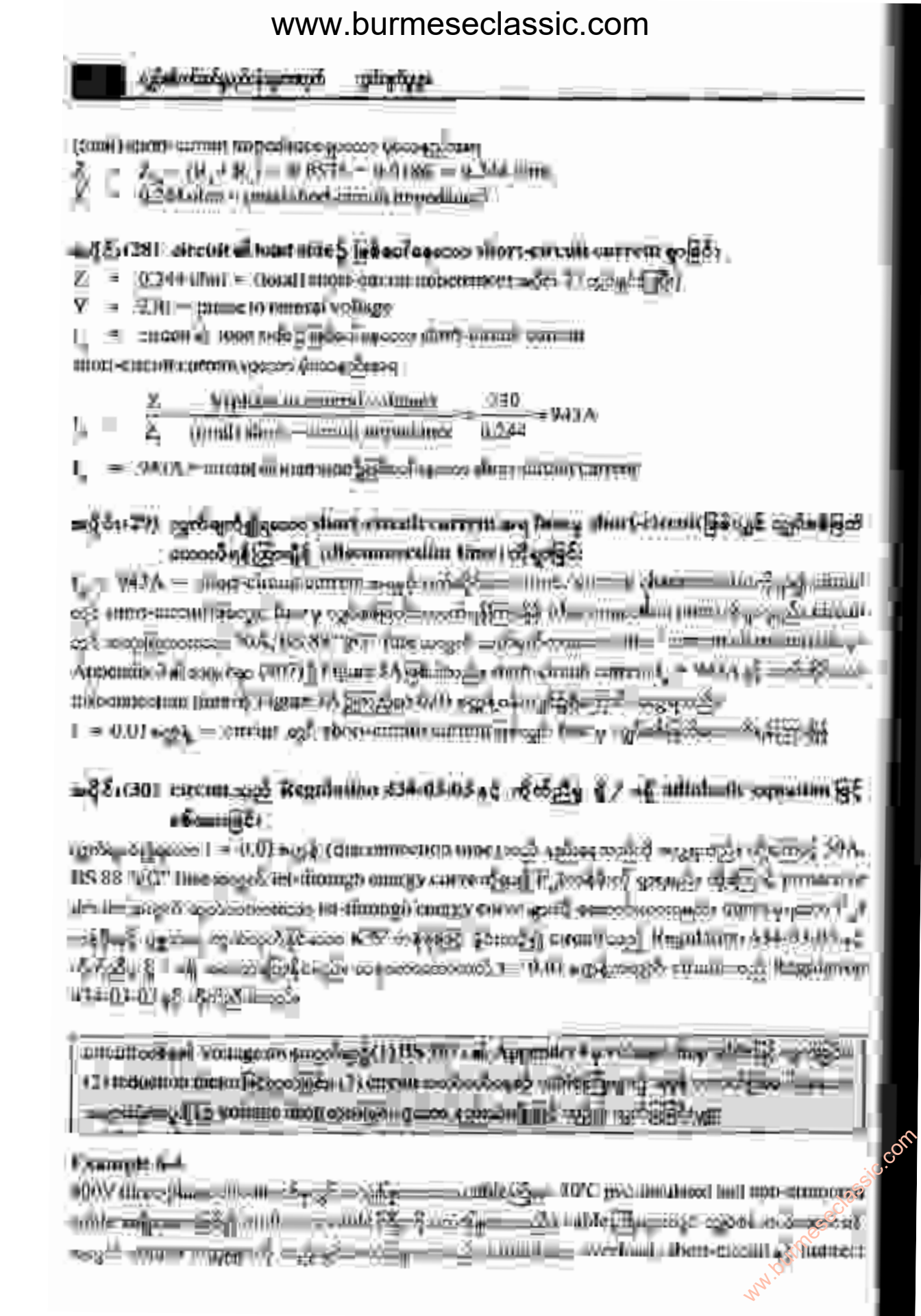

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ဆင့်ငယ်(15) total earth fault loop impedance တန်ဖိုးရှာခြင်း

ဆင့်ငယ်(16) တွက်ချက်ရရှိထားသော total earth fault loop impedance တန်ဖိုးကို BS 7671 ၏ Table 41D နှင့်တတ်နိုင်သမျှ နီးကပ်သည့်ပြွန်အား total earth fault loop impedance တန်ဖိုးနှင့် နှိုင်းယှဉ်ခြင်း

ဆင့်ငယ်(17) circuit ၏ live side တွင်ဖြစ်ပေါ်နေသော earth fault current ရှာခြင်း

ဆင့်ငယ်(18) တွက်ချက်ရရှိ earth fault current နှင့် circuit protective conductor ၏ current-carrying capacity တို့သည် line နှင့် neutral conductor တို့ထက် (disconnection time) ကိုရှာခြင်း

ဆင့်ငယ်(19) circuit သည် Regulation 543-01 ပါ နှင့်ကိုက်ညီမှု / မကိုက်ညီ adiabatic equation ကြောင်း ဆိုခြင်း

ဆင့်ငယ်(20) ဆင့်ငယ်(13) တွင် ရွေးချယ်ခဲ့သော circuit earth ကြိုးအရွယ် 1.5 mm² ကို သတ်မှတ်ပြောကြားခြင်း

ဆင့်ငယ်(21) circuit တွင် အသုံးပြုထားသော BS 88 "gG" fuse အတွက်လျှပ်စီးကြောင်းတန်ဖိုးများ (ampere ratings) ကိုရှာခြင်း

I_b = 41A = design current (ဖွဲ့စည်းထားသောလျှပ်)

I_n = circuit တွင် အသုံးပြုမည့် fuse ၏ လျှပ်စီးကြောင်းတန်ဖိုး (ampere)

I_z = current-carrying capacity (circuit ၏ လျှပ်စီးကြောင်းသယ်ဆောင်နိုင်မှုစွမ်းရည်)

$I_n \geq I_b$ ဖြစ်ရပါမည်။ ထို့ကြောင့် (hence) I_n = 41A ထက်ကြီးသော, fuse အတွက် သတ်မှတ်ထားသော standard ampere rating နှင့်တည်း ဖြစ်သည်ဖြစ်ရမည်။ ထို့ကြောင့် 50A ကို ရွေးချယ်သည်။

I_n = 50A = circuit တွင် တပ်ဆင်ရမည့် BS 88 "gG" fuse အတွက် လျှပ်စီးကြောင်းတန်ဖိုး

ဆင့်ငယ်(22) circuit အတွက် ကိုးခင်းထား cable ကြိုး၏ [illegible] = မဟုတ်ပါ။ အကယ်၍ [illegible] ကို I_z အဖြစ် ရွေးချယ်သည်။

I_b = 41A = ဖွဲ့စည်းထားသော circuit လျှပ်စီးကြောင်း

I_n = 50A = circuit တွင် အသုံးပြုသော BS 88 "gG" fuse အတွက် လျှပ်စီးကြောင်းတန်ဖိုး

[illegible] ဖြစ်ရပါမည်။

I_z [illegible]

circuit [illegible] [illegible] = $I_n - I_b$

circuit [illegible] [illegible] [illegible] overload protection [illegible]

circuit [illegible] [illegible] [illegible] overload protection [illegible] I_n = I_z [illegible]

I_n = I_z = 50A

I_z = 50A = circuit [illegible] [illegible] [illegible]

ဆင့်ငယ်(23) I_z [illegible] tabulated current-carrying capacity (I_t) [illegible]

I_t [illegible]

$I_t = I_z = \frac{I_n}{C_a \cdot C_g \cdot C_i \cdot C_c}$ A (see page 387) Appendix 4

I_t = 50A (ဆင့်ငယ် ၎င်းတွင် ရှာတွေ့ခဲ့ပြီး)

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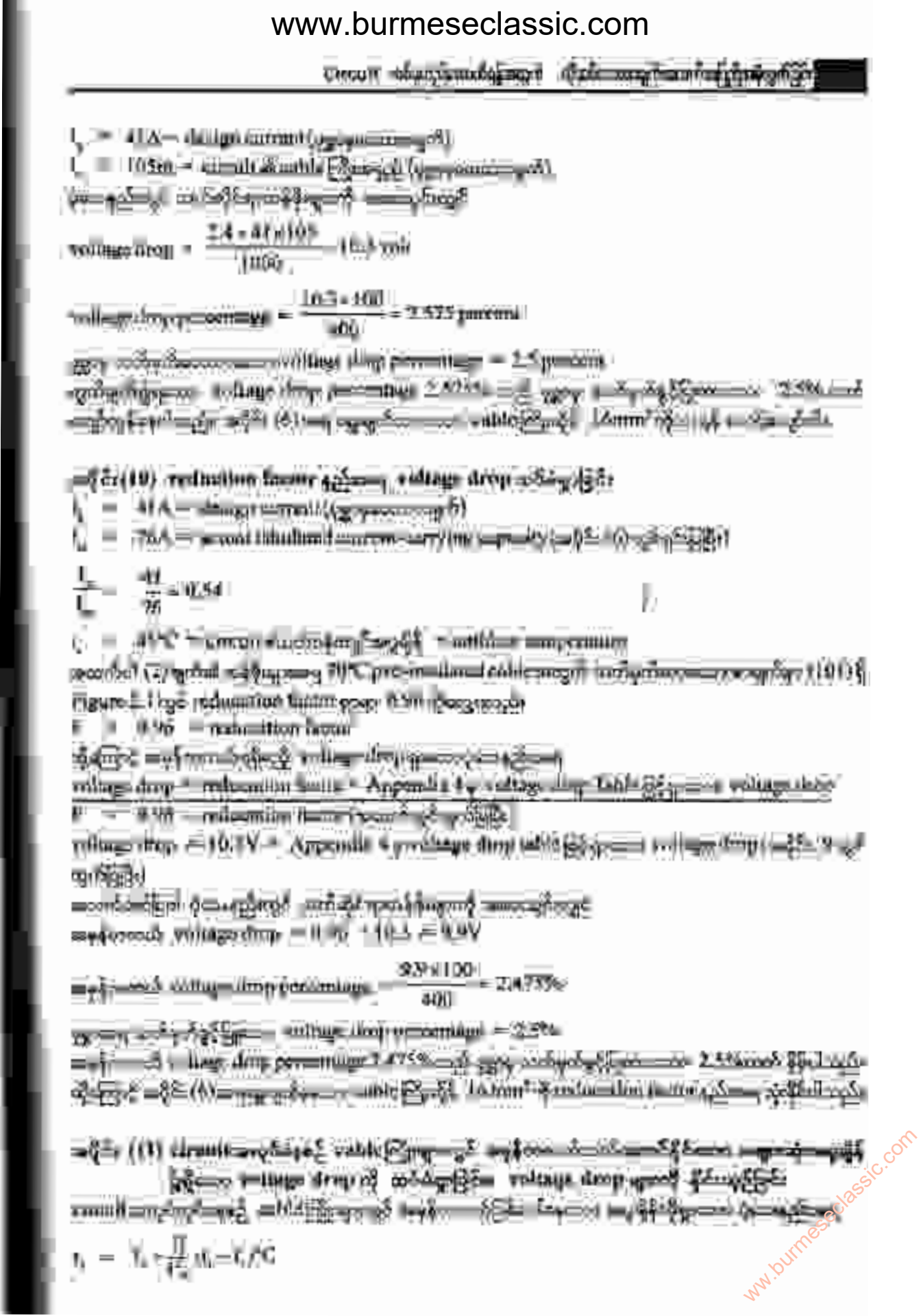

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[illegible]

$$t_1 = 45 + \frac{41}{75}(70 - 30)^{\circ}C = 66.6^{\circ}C$$

[illegible]

$$\text{design (mV/A/m)} = \left[\frac{330 + t_c}{330 + t_r}\right] \times \text{tabulated (mV/A/m)}$$

[illegible]

$$\text{design (mV/A/m)} = \left[\frac{330 - 66.6}{330 + 70}\right] \times 2 = \text{mV/A/m} = 2 \text{ mV/A/m}$$

[illegible]

$$\text{voltage drop} = \frac{\text{design (mV/A/m)} \times [illegible]}{1000} \text{ V}$$

[illegible]

$$\text{voltage drop} = \frac{2.5 \times 41 \times 115}{1000} = 0.6\text{V}$$

$$\text{voltage drop percentage} = \frac{8.9 \times 100}{400} = 2.25\%$$

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[illegible]

[illegible]

[illegible]

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[illegible] voltage drop Table 4D2B [illegible]

[illegible]

[illegible]

[illegible]

[illegible] voltage drop Table 4D2B [illegible]

[illegible] voltage drop Table 4D2B [illegible] (R) [illegible] (X) [illegible]

[illegible] cable [illegible] voltage drop [illegible]

R = [illegible] circuit [illegible] cable [illegible] 8 [illegible]

cable [illegible] mm² [illegible] tabulated voltage drop [illegible] Appendix 4 [illegible]

Table 4D2B [illegible] 6.4 mV/Am [illegible]

tabulated voltage drop = 6.4 mV/Am

cable [illegible] mm² [illegible] tabulated voltage drop = [illegible] mV/A/m [illegible]

[illegible]

$$\text{voltage drop} = \frac{\text{tabulated voltage drop} \times \text{[illegible]} \times \text{cable [illegible]}}{1000} \text{ volts}$$

tabulated voltage drop = 6.4 mV/A/m [illegible]

I_b = 26A = [illegible]

L = 40 m = cable [illegible]

[illegible]

$$\text{voltage drop} = \frac{\text{[illegible]}}{1000} = \text{[illegible]}$$

[illegible] voltage drop percentage [illegible] voltage drop [illegible]

voltage drop percentage = [illegible]

$$\text{voltage drop percentage} = \frac{8 \times 100}{400} = 2\% \text{ (three [illegible])}$$

[illegible] voltage drop percentage = 4%

[illegible] voltage drop percentage 2% [illegible] voltage drop percentage 4% [illegible]

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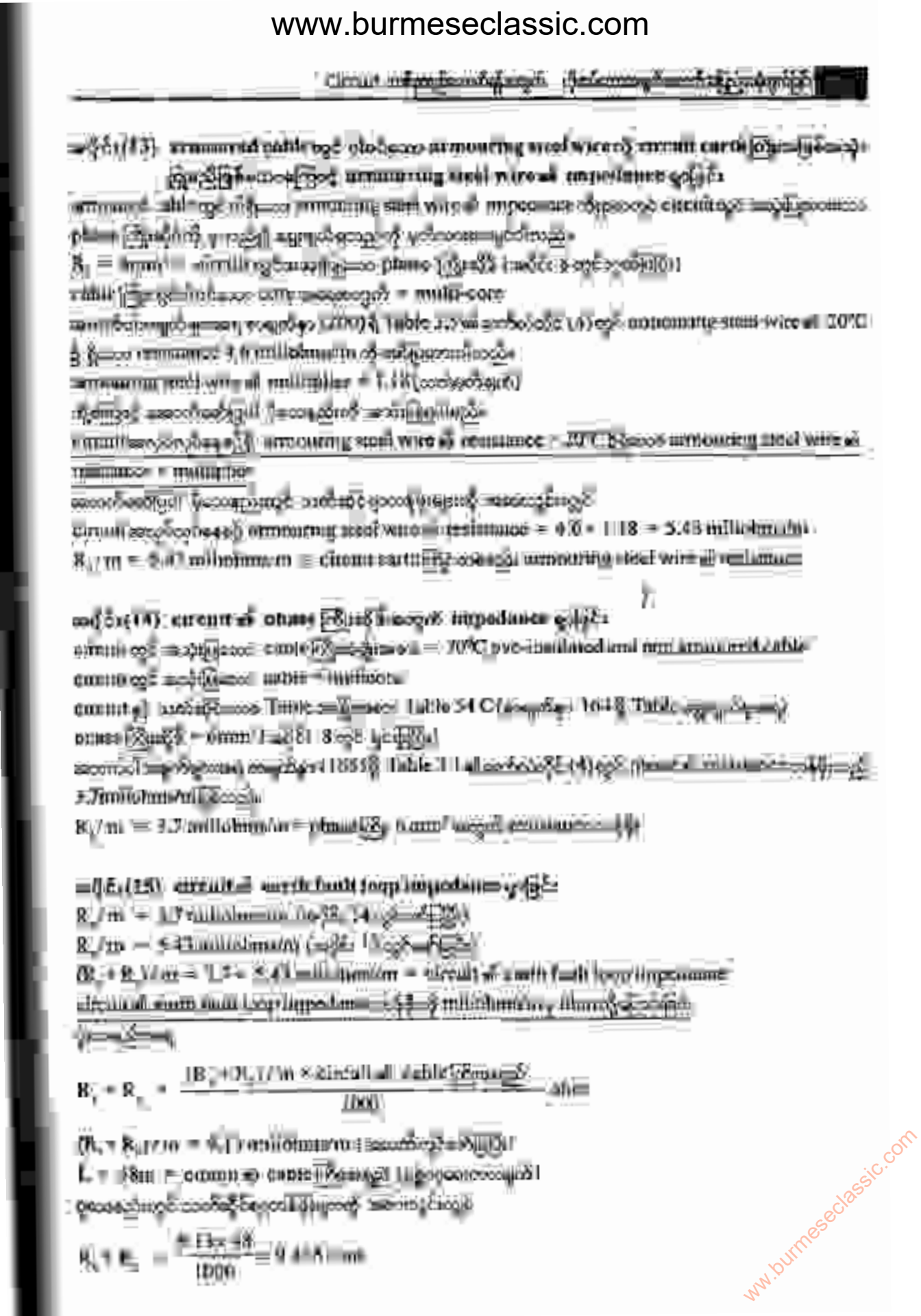

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[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Example 66

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

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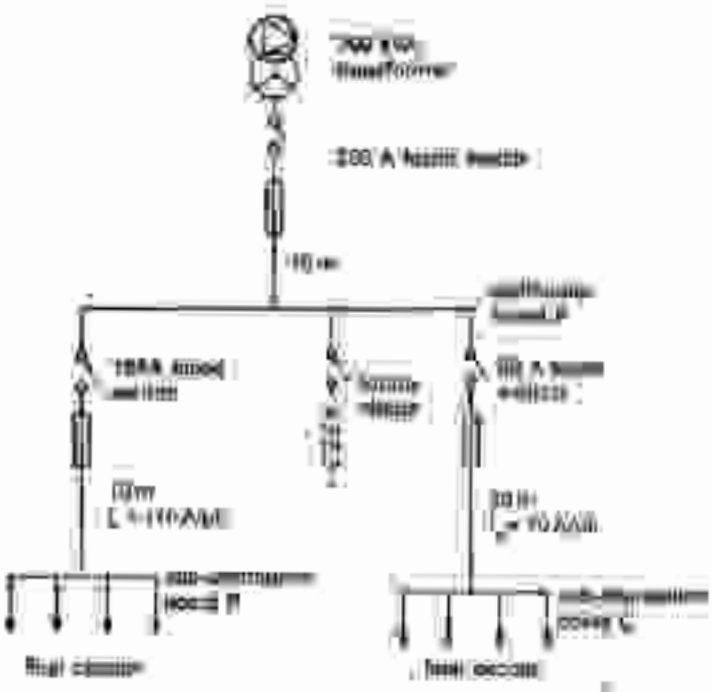

Figure 6.4 Installation schematic diagram for Example 6.2

First consider the conductor cross-sectional areas. As the smallest permissible size is to be [illegible] and there are grouping factors not considered [illegible] applied.

Unit from the transformer to distribution board A

$I_z = I_n = 250\text{A}$

From Table 4D4A (Column 7) it is found that the minimum conductor cross-sectional area that can be used is 120mm² having $I_z = 267\text{A}$.

From distribution board A to distribution board B, again from Table 4D4A Column 7, minimum conductor cross-sectional area is 35mm² having $I_z = 125\text{A}$ [illegible] exactly the same as I_n.

From distribution board A to sub-distribution board C $I_z = I_n = 80\text{A}$ and from Table 4D4A Column 7 the minimum conductor cross-sectional area for this cable is 25 mm² having $I_z = 102\text{A}$.

At this point in design the above conductor cross-sectional areas are provisionally with the requirements for voltage drop limitation. At the present time, protective devices have not yet been determined and only provisionally with the requirements for protective devices against overload current and fault current. Also, it is not possible to provide protection against short-circuit currents unless the characteristics of the protective devices are known. It is not possible to confirm that conductors concerned are adequately protected against short-circuit currents.

Further checks at the voltage drop

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From Column 4 of Table 4.1(f) the following values of mV/Am are obtained (all in millivolts):

	[mV/A/m]	[mV/A/m]	[mV/A/m]
[illegible]	1.50	0.165	1.50
[illegible]	1.10	0.140	1.10
[illegible]	0.35	0.135	0.35

[illegible] given the power factor of the distribution circuit the mV/A/m values are used in each case and the voltage drops are calculated as follows.

From the midpoint to the [illegible] load:

$$\text{voltage drop} = \frac{0.35 \times 115 \times 250}{1000} V = 9.88\,V$$

[illegible] = 250 A has been used because it will [illegible] from distribution board A.

From [illegible] board A to sub-distribution board B:

$$\text{voltage drop} = \frac{1.10 \times 15 \times 115}{1000} V = 1.87\,V$$

All the [illegible] the specified limitation in voltage drop.

Now [illegible] the prospective short-circuit [illegible].

At the terminals of the transformer:

$$I_{sc} = \frac{230}{\sqrt{0.016^2 + 0.04^2}} A = 5.35\,kA$$

As a matter of interest another way of estimating the prospective short-circuit current is to use the %Z of the transformer. The rating given on the transformer rating plate was:

$$I_{sc} = \frac{\text{kVA rating} \times 1000}{\text{volts} \times \%Z} = \frac{100}{0.04} A$$

The other important relationships will [illegible] are:

$$\text{R phase} = \frac{\%R \times \text{volts}}{\text{kVA rating} \times 1000} \text{ ohm}$$

$$\text{X phase} = \frac{\%X \times \text{volts}}{\text{kVA rating} \times 1000} \text{ ohm}$$

with %R being the percentage [illegible]

%X being the [illegible]

V_L being the line-to-line voltage.

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[illegible]

$$Z_{pu} = \sqrt{[illegible]} = [illegible]$$

$$\%Z = \frac{[illegible]}{[illegible]} = [illegible]\%$$

Using [illegible] to obtain the prospective short-circuit current:

$$I_{sc} = \frac{[illegible]}{[illegible]} \times \frac{100}{[illegible]} A = [illegible] A$$

Because the prospective short circuit is only [illegible] and the primary is [illegible] for the two-winding transformer listed in the identification board Panel [illegible] that is not adequate [illegible] considerably in excess of [illegible] A. It is necessary to reduce the prospective short-circuit current to [illegible] and A.

In the present case, because all the [illegible] are protected by [illegible] there [illegible] and have adequate breaking capacity. Regulation [illegible] applies, that is not necessary to check the thermal capabilities of the cables under short-circuit conditions using the [illegible] method of Regulation [illegible].

Nevertheless, the above results only apply if [illegible] the method to be used, the respective [illegible] should be then identified and was calculated. In order to [illegible] prospective short-circuit current it is necessary to know the [illegible] of the [illegible] at normal service. It is usually assumed [illegible] for some thermoplastic. Regulation [illegible] permits that the [illegible] may exceed "[illegible]" [illegible]. The [illegible] of the normal [illegible] is [illegible].

The necessary [illegible] and [illegible] values may be obtained directly from the [illegible] [illegible] but these sometimes give [illegible] values of [illegible].

An [illegible] of the mV/A/m values given in Appendix [illegible] can be used "[illegible]" them at [illegible].

Using the [illegible] method, for the main incoming circuit:

$$R_1 = \frac{[illegible]}{[illegible]} \text{ ohm}$$

$$= \frac{[illegible]}{[illegible]} \text{ ohm}$$

$$= [illegible] \text{ ohm}$$

$$X_1 = \frac{[illegible]}{[illegible]} \text{ ohm}$$

$$= \frac{[illegible]}{[illegible]} \text{ ohm}$$

$$= [illegible] \text{ ohm}$$

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The [illegible] distributed bus A is given by

$$I_{fault} = \frac{2.16}{\sqrt{(0.016+0.0015)^2+(0.04+0.0008)^2}} A = 51.7mA$$

Similarly for the [illegible] from the bus A to all [illegible] bus B:

$$R_1 = \frac{1.76\times15\times250}{\sqrt{3}\times1000\times300}\ ohm$$

$$= 0.0076ohm$$

$$X_1 = \frac{0.14\times15}{\sqrt{3}\times1000}\ ohm$$

$$= 0.0012ohm$$

The [illegible] bus A to bus B is given by

$$I_{fault} = \frac{2.16}{\sqrt{(0.016+0.0015+0.0076)^2+(0.04+0.0008+0.0012)^2}}$$

For the fault from substation bus A to sub-[illegible] bus C:

$$R_1 = \frac{1.5\times18\times250}{\sqrt{3}\times1000\times300}\ ohm$$

$$= 0.013ohm$$

$$X_1 = \frac{0.14\times18}{\sqrt{3}\times1000}\ ohm$$

$$= 0.0014ohm$$

The [illegible] bus A to bus C is given by

$$I_{fault} = \frac{2.16}{\sqrt{(0.016+0.0015+0.013)^2+(0.04+0.0008+0.0015)^2}}$$

$$= 44.6A$$

The next stage in design is to check the earth fault loop impedance for the circuits considered and at the same time, wherever the [illegible] are required to be calculated the [illegible] built-up impedance values from bus A to [illegible] bus B, bus A to sub-[illegible] bus C and bus A to [illegible] bus D will be used with [illegible].

Again the [illegible] value will be used:

$$R_1 = \frac{0.33\times10}{\sqrt{3}\times1000}\ ohm = 0.0019\Omega$$

$$X_1 = 0.0002\Omega$$

The [illegible] are [illegible] the [illegible] from Table 2.11, Column [illegible].

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[redacted] resistance values have to be corrected to 60°C as mentioned in [redacted]

Thus:

$$R_1 = \frac{0.23 \times 10 \times 1.18}{1000} \text{ ohm} = 0.0084 \text{ ohm}$$

$$X_1 = \frac{0.08 \times 10}{1000} = 0.0008 \text{ ohm}$$

The earth fault loop impedance distribution board A is given by:

$$Z_e = \sqrt{(0.016 + 0.0019 + 0.0084)^2 + (0.04 + 0.0008 + 0.0063)^2} \text{ ohm}$$

$$= \sqrt{(0.0263)^2 + (0.0471)^2} \text{ ohm}$$

$$= 0.051 \text{ ohm}$$

The [redacted] current [redacted] in Appendix 3 of BS 7671 [redacted] for the 250 A fuse, hence it is necessary to obtain it from the fuse manufacturer.

A typical [redacted] fuse gives [redacted] 0.0004 ohm [redacted] fault loop impedance = 0.15 ohm. The [redacted] circuit complies as regards disconnection time.

From the cable manufacturer's [redacted] = [redacted] and [redacted] the minimum [redacted] = 21 mm²

First check if the cross-sectional area complies with Table 54G of BS 7671:

According to this [redacted] should be [redacted]

$$\frac{115}{51} \times \frac{120}{2} \text{ mm}^2 = 135.3 \text{ mm}^2$$

The [redacted] complies with Table 54G and there is [redacted] to check for the [redacted] especially if the [redacted] and [redacted] conditions

To determine the actual fault loop impedance at distribution boards B and C it is first necessary to recalculate the resistance at [redacted] (70°C for [redacted]). The following [redacted] value [redacted] with a correction factor. The method remains the same.

The armouring temperature was assumed not to rise appreciably under earth fault conditions and was previously calculated at the normal operating temperature of 60°C (i.e. 10°C less than the [redacted] temperature). Thus no change is needed.

$$R_1 = \frac{0.35 \times 40}{2 \times 1000} \text{ ohm} = 0.0070 \text{ ohm}$$

X_1 = 0.0008 ohm (as before)

R_2 = 0.0084 ohm (as before)

X_2 = 0.0063 ohm (as before)

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For the distribution circuit from distribution board A to sub-distribution board B

$$R_1 = \frac{110 \times 15}{35 \times 1000}\ \text{ohm}$$

$$= 0.0047\ \text{ohm}$$

X_{1} at 50Hz = 0.0031 ohm

From Table 2.1/2, column 6 and 7

$$R_2 = \frac{0.015 \times 110}{1000}\ \text{ohm}$$

$$= 0.0036\ \text{ohm}$$

X_2 = [Negligible]

The total fault loop impedance at the distribution board B is the vectorial sum of its resistance component is made up of

[illegible] resistance of the transformer	0.004 ohm
R_1 = phase resistance of main distribution cable at 70°C	0.0047 ohm
R_2 = earthing conductor resistance at 60°C	0.0036 ohm
R_3 = phase conductor of distribution circuit to board B at 70°C	0.0095 ohm
R_4 = earthing conductor resistance from board B to [illegible] at 60°C	0.0256 ohm
Total estimated	0.0669 ohm

Its reactance component is made up of

[illegible] resistance of the transformer	0.00 ohm
X_1 = phase conductor of main distribution circuit	0.0031 ohm
X_2 = earthing of main distribution circuit	0.00 ohm
X_3 = phase conductor of distribution circuit to board B	0.0013 ohm
X_4 = earthing conductor of distribution board B to [illegible]	0
Total reactance	0.0044 ohm

Thus

$$Z_s = \sqrt{0.0669^2 + 0.0044^2}\ \text{ohm} = 0.067\ \text{ohm}$$

From Table 41.1 of BS 7671 the maximum earth fault loop impedance for a disconnection in 0.35 sec for final circuits

In order to be able to apply Table 54.7 the cross-sectional area for the armour wire has to be less

$$\frac{\pi}{4} \times 1.6^2\ \text{mm}^2 = 1.6\ \text{mm}^2$$

A check of the cable manufacturer's data has to be made and it will be found that the cable will be [illegible] a typical value being 85mm² for the armour cross-sectional area.

For the distribution circuit from [illegible]

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$R_1 = \frac{[illegible]}{\sqrt{3} \times 1000}$ ohm

$= [illegible]$ ohm

X_1 per [illegible] $= [illegible]$ ohm

From Table 3.11 Column 6 and 7

$R_2 = \frac{[illegible]}{1000}$ ohm

$= [illegible]$ ohm

$X_2 = [illegible]$

The earth fault loop impedance [illegible] is the sum of the following resistance components as made up of

[illegible] of the transformer	[illegible] ohm
R_1 for phase conductor of main distribution circuit (at 70°C)	[illegible] ohm
R_2 for armoring of main distribution cable (at 60°C)	0.0054 ohm
R_3 for phase conductor of distribution cable to Board C (at 70°C)	[illegible] ohm
R_4 for armoring of distribution cable to Board C (at 60°C)	[illegible] ohm
Total resistance	0.0869 ohm

[illegible] component is made up of

[illegible] resistance of the transformer	[illegible] ohm
X_1 for phase conductor of main distribution circuit	0.0088 ohm
X_2 for armoring of main distribution cable	[illegible] ohm
X_3 for phase conductor of distribution cable to Board C	0.0015 ohm
X_4 for armoring of distribution cable to Board C is negligible	[illegible]
Total reactance	0.0983 ohm

Thus

$Z_s = \sqrt{0.0869^2 + 0.0983^2} = 0.1312$ ohm.

From [illegible] for an 80A BS88 [illegible] given as [illegible] ohm.

Again it will be found that Table 3.5(c) is [illegible] used to check [illegible] thermal [illegible] for the resulting [illegible] fault condition

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APPENDIX-1
CURRENT-CARRYING CAPACITY AND VOLTAGE DROP FOR COPPER CONDUCTORS

Current-carrying Capacity

For full information on the selection of cable sizing, current rating factors, see Appendix 4 of BS 7671.

In this simplified approach it is assumed that the overcurrent device will be providing both fault and overload protection.

Procedure

(1) the design current I_b of the circuit must be established

(2) the nominal current (or setting) I_n of the protective device is then selected so that I_n is greater than or equal to I_b

$I_n \geq I_b$ for overload and short-circuit protection

$(I_n = I_b$ for only short-circuit protection)

The minimum current-carrying capacity of the associated cable it is then given by

$$I_z = \frac{I_n}{C_a C_g C_c C_f}$$

or simultaneously occurring factors.

Where

C_a is the correction factor for ambient temperature,

C_g is the correction factor for grouping,

C_c is the correction factor for conditions of external thermal resistivity (where cables are buried in the ground),

C_f is the correction factor for semi-enclosed fuse to BS 3036 and 1 for HRC fuse and mcb,

I_n is the nominal rating of the overload protective device (or the nominal setting of the overload protection and short-circuit protection (2) where both are provided),

I_z is the nominal rating of the overload protective device or short-circuit protection where both are provided (thermal insulating materials are those materials which have a thermal resistivity greater than 2.5 K m/W),

I_b is the design current,

I_n is the nominal rating of the protective device,

I_z is the current-carrying capacity of the cable.

Thermal insulation material is [illegible]

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APPENDIX-2

TABLE 4A

Schedule of Methods of Installation of Cables

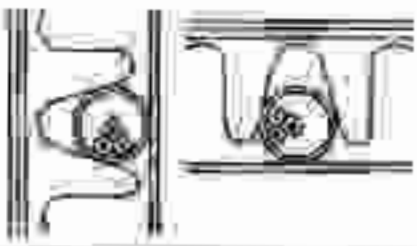
Installation method		Examples	Applications
Number	Description		
1	2	3	4
Cables in conduit in thermally insulating wall			
1	Single-core cables, in conduit, in a thermally insulating wall, having a thermal conductivity not greater than 1 W/m K		Method 1
Cables in trunking or ducting			
2	Multi-core cable, in trunking, on a wall or ceiling or horizontal perforated cable tray, or vertical perforated cable tray		
Cables in conduit on a wall or ceiling or in trunking			
3	Single-core or multi-core cable, in conduit or trunking, fixed directly to a wall or ceiling		Method 1
4	Single-core or multi-core cable, in conduit or trunking, on a perforated cable tray, or on a cable ladder, or supported by a bracket or cleats or the like		Method 2
5	Multi-core cable, having a thermally insulating wall or ceiling, in conduit or trunking, fixed directly to a wall or ceiling		Method 1

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TABLE-4A (continued)

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TABLE 1A (continued)

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TABLE 4A (continued)

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TABLE 4A (continued)

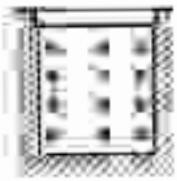
16			
22			

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Table 4B1

Common factors for groups of more than one circuit of single-core cables or multi-core cables to be applied to correspondent current-carrying capacity for a single circuit in Tables 4D1A to 4J4A, 4E1B and 4E2B, 4F1B and 4F2B, 4G1B, 4H1B

Arrangement (cables touching)	Number of circuits or multi-core cables												
	1	2	3	4	5	6	7	8	9	10	12	14	16
Bunched in air, on a surface, embedded or enclosed	1.00	0.80	0.70	0.65	0.60	0.57	0.54	0.52	0.50	0.48	0.45	0.43	0.41
Single layer on wall or floor	Touching	1.00	0.85	0.79	0.75	0.73	0.72	0.72	0.71	0.70	0.70	0.68	0.68
	Spaced	1.00	0.94	0.91	0.89	0.88	0.87	0.86	0.86	0.85	0.85	0.84	0.84
Single layer multicore on a perforated cable tray system horizontal or vertical	Touching	1.00	0.88	0.82	0.77	0.75	0.73	0.73	0.72	0.72	0.71		
	Spaced	1.00	0.91	0.89	0.88	0.87	0.86	0.85	0.85	0.85	0.84		
Single layer multicore on a cable ladder system or cleats etc.	Touching	1.00	0.87	0.82	0.80								
	Spaced	1.00	1.00	0.99	0.98								
Single layer multicore on a horizontal perforated cable tray system or vertical perforated cable tray system		1.00	0.88	0.82	0.79	0.76	0.75	0.73	0.72	0.72	0.71	0.70	0.70

TABLE 4B2

Correction factors for Mineral insulated cables installed on Perforated Trays, to be applied to the current carrying capacity for similar circuits in reference method 31 in Table 4F1A

Type of cable	Arrangement	Number of trays	Number of circuits per tray				
			1	2	3	4	6
Touching	Trays mounted one above the other	1	1.00	0.88	0.82	0.77	0.73
		2	0.88	0.80	0.76	0.73	0.70
		3	0.82	0.76	0.73	0.70	0.68
		6	0.78	0.73	0.70	0.68	0.66
Spaced	Trays mounted one above the other	1	1.00	1.00	0.98	0.96	0.93
		2	1.00	0.99	0.96	0.93	0.89
		3	1.00	0.98	0.95	0.92	0.87
		6	1.00	0.97	0.93	0.90	0.86

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TABLE 4B3

Correction factors for cabinet insulation (combined) for installations specified in items 18, 19 and 20 of Table 4A1*

The correction factors mentioned below relate to cables installed in cabinet insulation (items 18 to 20 of Table 4A) and are applicable to the current-carrying capacities for reference methods 1 or 3 of Table 4A as given in the relevant tables of this appendix.

Correction factors

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TABLE 4C1

Correction factors for ambient temperature where protection is [illegible 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 unit enclosed to BS 3036 the table also applies where the device is intended to provide overload protection

Type of [illegible]	Ambient temperature °C													
	25	30	35	40	45	50	55	60	65	70	75	80	85	90
[illegible]														
[illegible]	70°C	1.0	1.0	0.94	0.87	0.79	0.71	0.61	[illegible]					
[illegible]	[illegible]	1.0	1.0	0.95	0.89	0.84	0.77	0.71	0.63	0.55	0.45	0.32		
[illegible]	[illegible]	1.0	1.0	0.95	0.91	0.87	0.82	0.76	0.71	0.65	0.58	0.50	0.41	0.30
[illegible]	[illegible]	1.0	1.0	0.93	0.87	0.79	0.71	0.61	[illegible]					
[illegible]	[illegible]	1.0	1.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.0	1.0	0.93	0.87	0.79	0.71	0.61	[illegible]					
	60°C	1.0	1.0	0.95	0.91	0.87	0.82	0.76	0.71	0.65	0.58	0.50	0.41	0.30

TABLE 4C2

Correction factors for ambient temperature where the overload protective device is a [illegible] unit enclosed to BS 3036

Type of [illegible]	Ambient temperature °C													
	25	30	35	40	45	50	55	60	65	70	75	80	85	90
[illegible]	[illegible]	1.0	1.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.0	1.0	0.97	[illegible]	[illegible]	0.87	0.84	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.0	1.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.0	1.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.0	1.0	0.97	[illegible]	[illegible]	0.87	0.84	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	60°C	1.0	1.0	0.98	0.95	0.91	0.87	0.82	0.76	0.71	0.65	0.58	0.50	0.41

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TABLE 41(1)

Minimum earth fault loop impedance (Z) for fuse, BS 0[illegible] disconnection time with U_o 240V (see Regulation 413-02-07)

(i) General purpose (GG) fuses to BS 88 parts 2 and 6

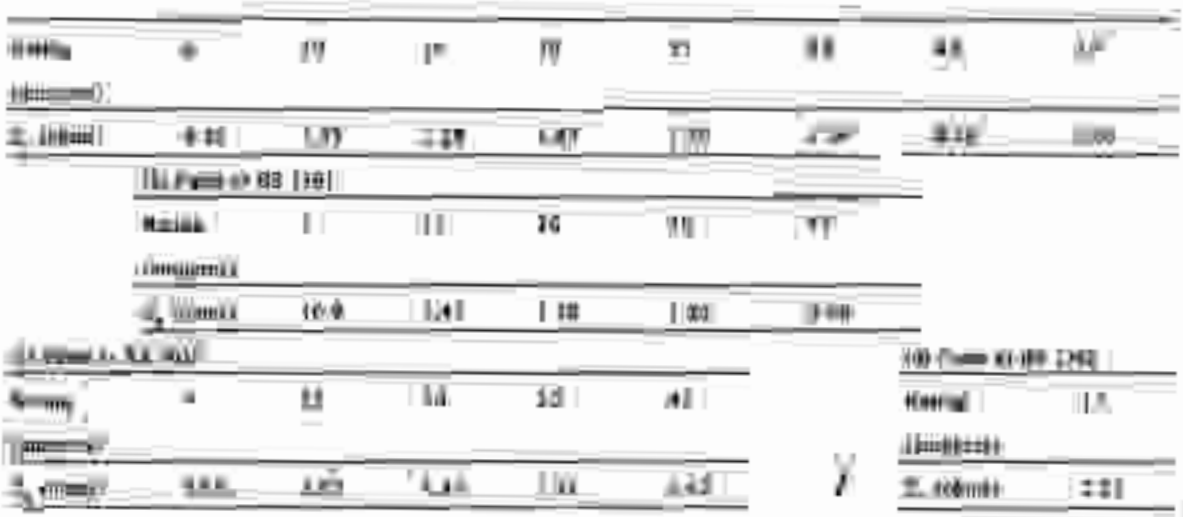

TABLE 41(2)

Maximum earth fault loop impedance (Z) for compliance with disconnection times for circuits with U_o 240V (see Regulation 413-02-04) and (see Regulations 413-02-11 and 413-02-14)

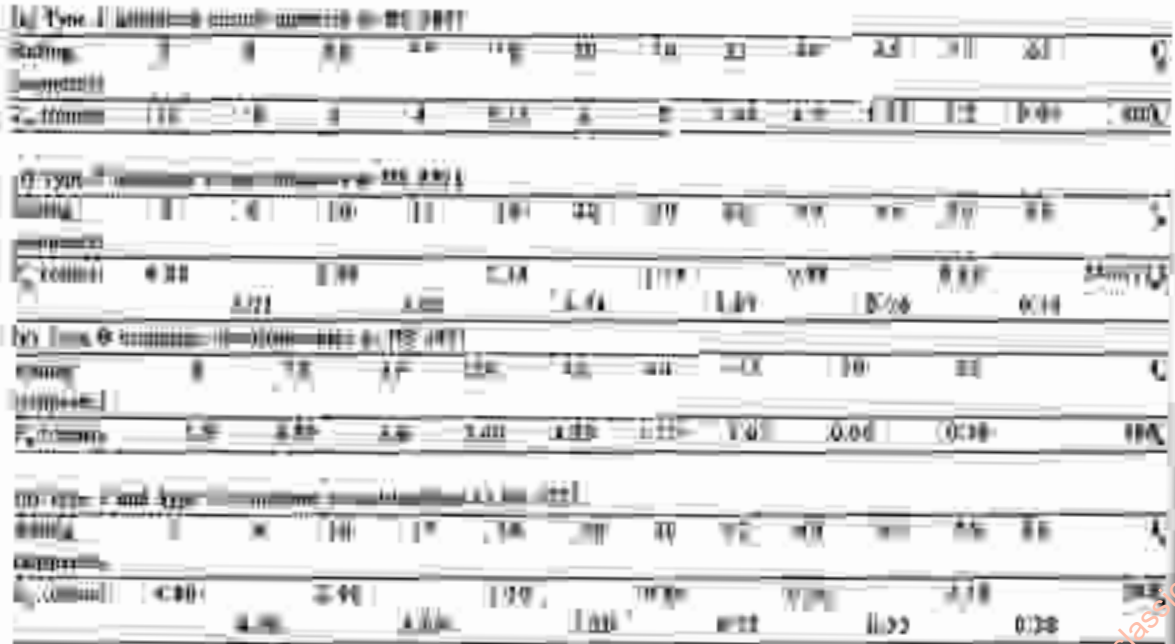

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TABLE 41C

Maximum impedance of circuit protective conductors related to the final circuit protective device
(see Regulation 413-02-12)

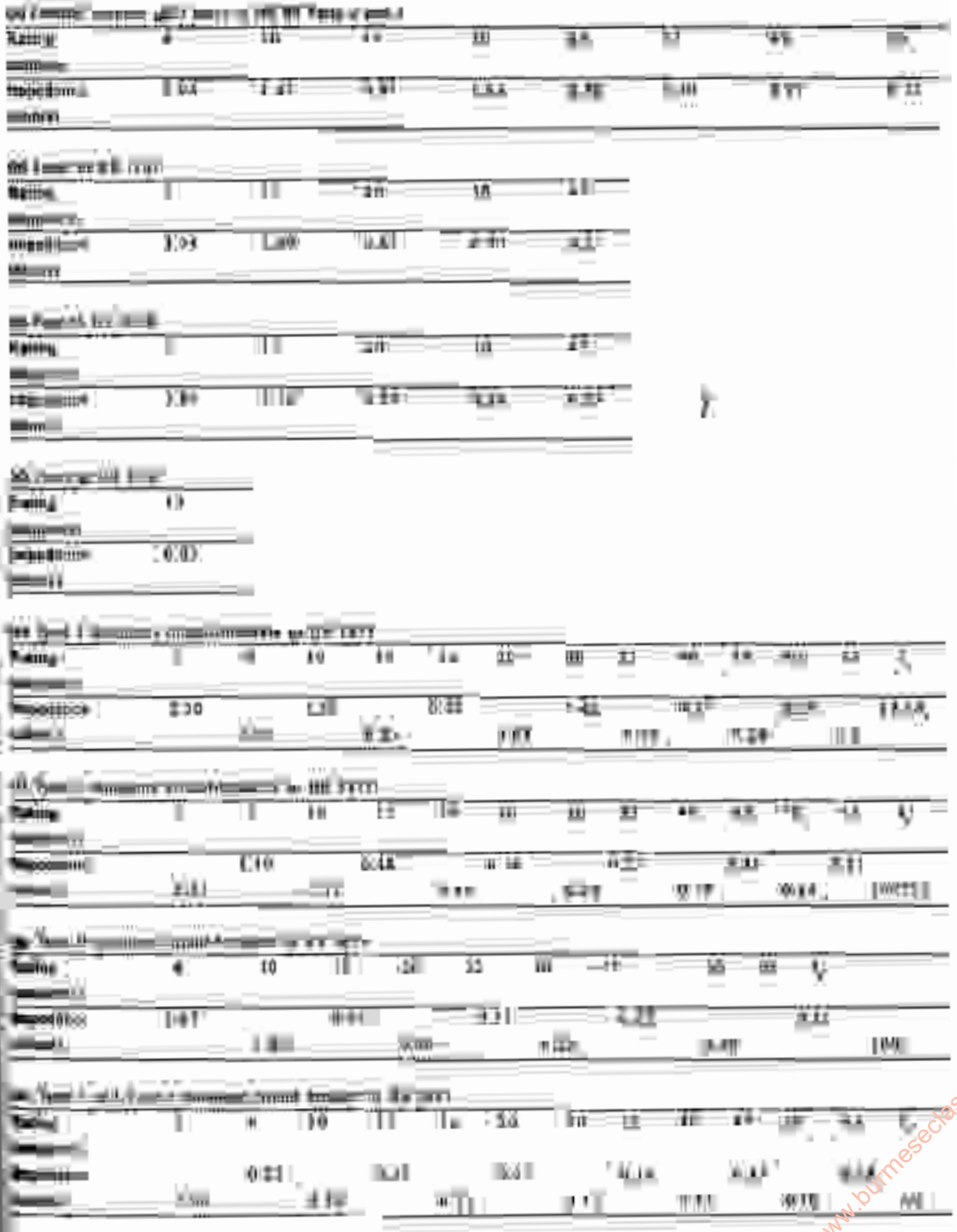

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TABLE 41B

Maximum earth fault loop impedance (Z_s) for 5s disconnection time with U_0 = 230 V
(see Regulation 411.3.2.3 and 411.3.2.4)

(a) Circuits protected by BS 88-2 fuses to BS 88-6 Type 2 and 3

Nominal current rating (A)	6	10	16	20	25	32	40	50
Z_s (ohms)	3.83	2.30	1.44	1.15	0.92	0.72	0.57	0.46

Nominal current rating (A)	63	80	100	125	160	200
Z_s (ohms)	0.36	0.29	0.23	0.18	0.14	0.11

(b) Circuits protected by BS 1361 fuses

Nominal current rating (A)	5	15	20	30	45	60	100
Z_s (ohms)	7.67	2.55	1.91	1.28	0.85	0.64	0.38

(c) Circuits protected by BS 3036 fuses

Nominal current rating (A)	5	15	20	30	45	60	100
Z_s (ohms)	7.67	2.55	1.91	1.28	0.85	0.64	0.38

(d) Circuits protected by BS 3871 MCBs

Nominal current rating (A)	5	15	20	30	45	60	100
Z_s (ohms)	7.67	2.55	1.91	1.28	0.85	0.64	0.38

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TABLE 43A

Values of K for common materials for calculation of the effects of fault current

The data is applicable only for disconnection times up to 5 seconds

For longer times the cable manufacturer shall be consulted

TABLE 52D (Regulation 523-01)

Maximum continuous operating temperatures

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TABLE 52C (Regulation 534-01)

MINIMUM NOMINAL CROSS-SECTIONAL AREA OF CONDUCTOR

TYPE OF WIRING SYSTEM	USE OF THE CIRCUIT	MATERIAL	CONDUCTOR MINIMUM PERMISSIBLE NOMINAL CROSS-SECTIONAL AREA mm²
Cables and insulated conductors	Power and lighting circuits	Cu	4.0
		Al	16.0
	Signalling and Control circuits	Cu	0.5
Bare conductors	Power Circuits	Cu	10
		Al	16
	Signalling and Control Circuits	Cu	4
Flexible connections with insulated conductors and cables	For a specific appliance		As specified in the relevant British Standard
	For any other application	Cu	0.5
	Extra-low voltage circuits for the supply of safety services		0.5

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TABLE 4A5

[illegible] with cable, where the assumed initial temperature is 70°C

[illegible]	[illegible]			
	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

TABLE 4A6

Values of k for protective conductors [illegible] in a cable [illegible] with cable, where the assumed initial temperature is 70°C or greater

[illegible]	[illegible]			
	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

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TABLE 54D

Values of k_1 for protective conductor as a result of rise of temperature of cable

Material of conductor	Insulation Material			
	PVC	85°C rubber	90°C thermosetting	MIMS
Bare cable, exposed neither to touch nor to risk of damage to adjacent material	60	82	90	115
Bare cable, not exposed to touch or to risk of damage to adjacent material	45	66	81	105
Bare cable in contact with wood, paper or other material having similar thermal properties	45	59	71	91
Sheath of cable	45	59	71	85
Flat conductor	35	45	55	70

TABLE 54E

Minimum cross-sectional area of protective conductor to withstand the effects of prospective fault current

Cross-sectional area of phase conductor	Minimum cross-sectional area of copper protective conductor	
	If the same material as that of the phase conductor	If the material is different from that of the phase conductor
S	S_p	$S_p \times \frac{k_1}{k_2}$
$S \leq 16$	S	$S \times \frac{k_1}{k_2}$
$16 < S \leq 35$	16	$16 \times \frac{k_1}{k_2}$
$S > 35$	$\frac{S}{2}$	$\frac{S}{2} \times \frac{k_1}{k_2}$

Where

S_p = the area of the protective conductor, in square millimetres;

S = the area of the associated phase conductor, in square millimetres;

k_1 = the value of k for the protective conductor, selected from TABLES 54B to 54C, as appropriate;

k_2 = the value of k for the phase conductor, selected from TABLES 54B to 54C, as appropriate.

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APPENDIX I

TIME/CURRENT CHARACTERISTICS OF OVERCURRENT PROTECTIVE DEVICES

[illegible] over current devices [illegible] time current characteristics [illegible] current [illegible] fault current [illegible] [illegible] overcurrent device [illegible] [illegible] [illegible]

This appendix gives the time/current characteristics of the following overcurrent devices

Figure 1	HRC fuses to BS 88 (M)
Figure 2A & 2B	Semi-enclosed fuses to BS 3036
Figure 3A & 3B	HRC fuses to BS 88 (C) and (D)
Miniature circuit breakers (m.c.b.s) to IEC 157-1	
Figure 4	Type 1
Figure 5	Type 2
Figure 6	Type 3
Figure 7	Type B
Figure 8	Type C

In all of these time/current characteristics, no allowance for the lowest operating time for compliance with the Standard has been made in the form for determining the limiting value of earth fault loop impedance [illegible] Column (4) of Figure 4.1.

[illegible]

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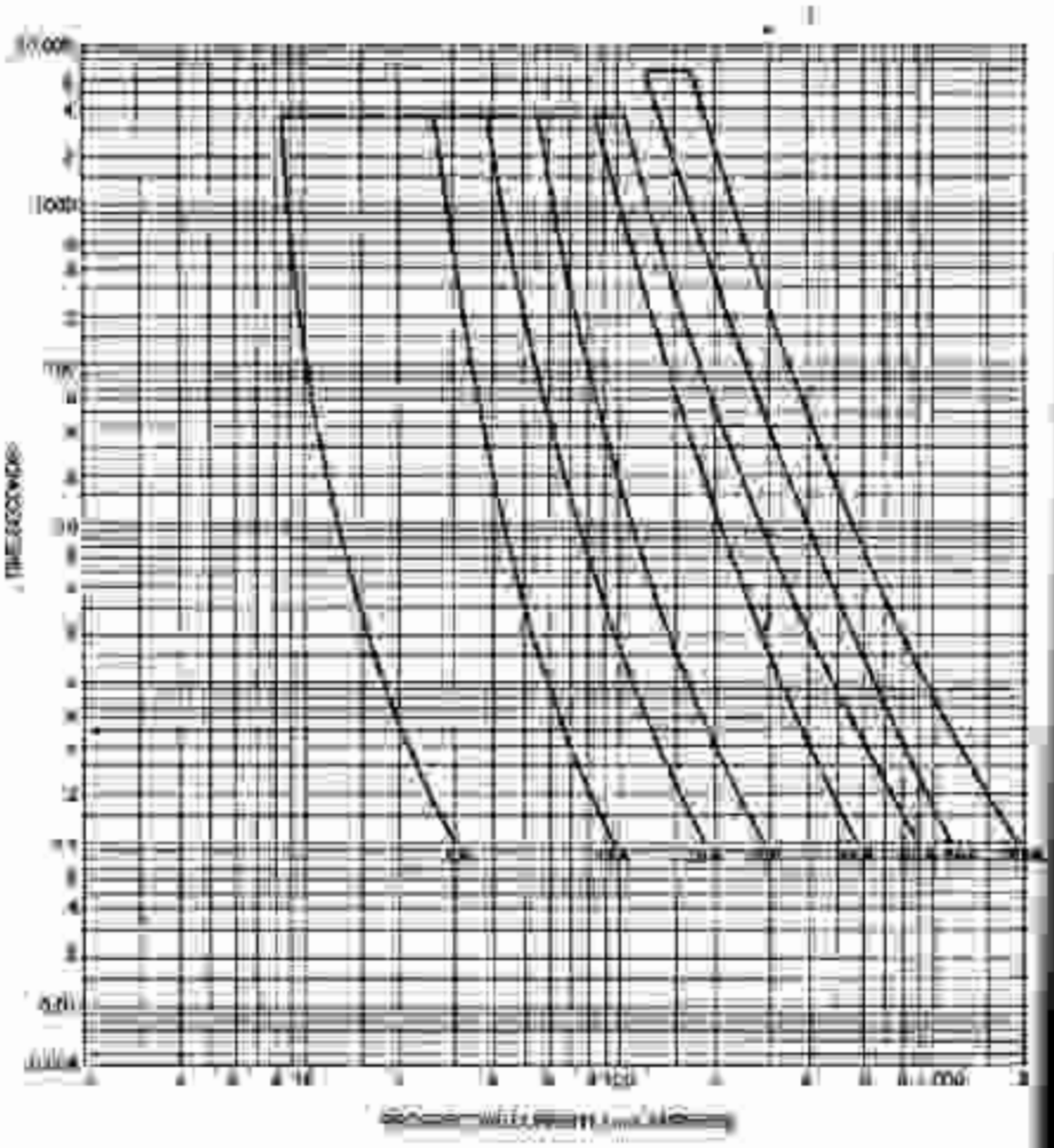

FUSE	CHARACTERISTIC			
RATING	0.1sec	0.2sec	0.5sec	5sec
15A	225A	80A	30A	18A
20A	280A	240A	200A	125A
60A	880A	720A	600A	330A
100A	1800A	1480A	1200A	650A

FIG.1

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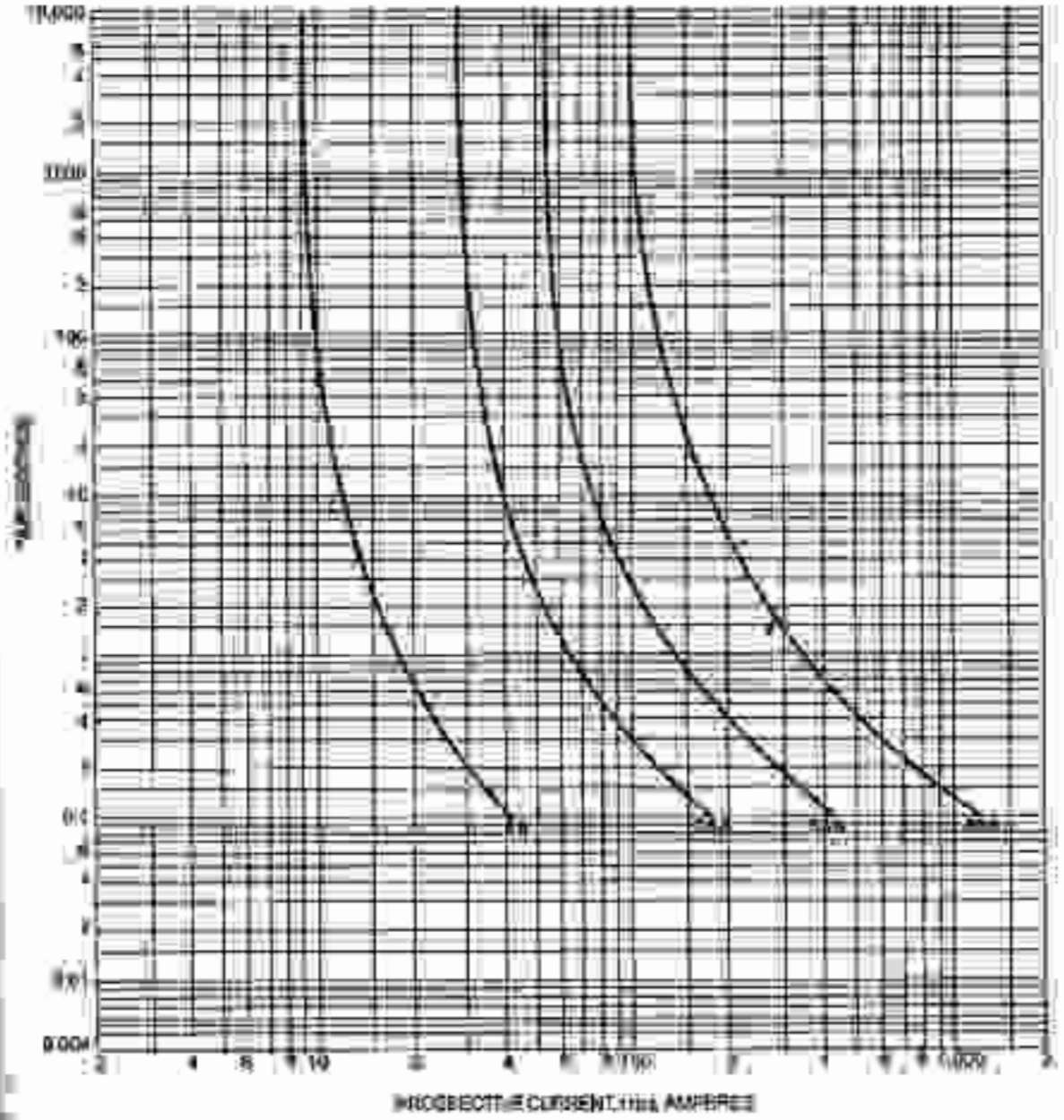

FUSE RATING	CURRENT FOR TIME			
	0.1sec	0.5sec	1.0sec	5sec
5A	50A	12A	8.5A	7.5A
15A	150A	45A	30A	21A
30A	450A	180A	120A	85A
60A	1200A	600A	550A	200A

Fig 3A

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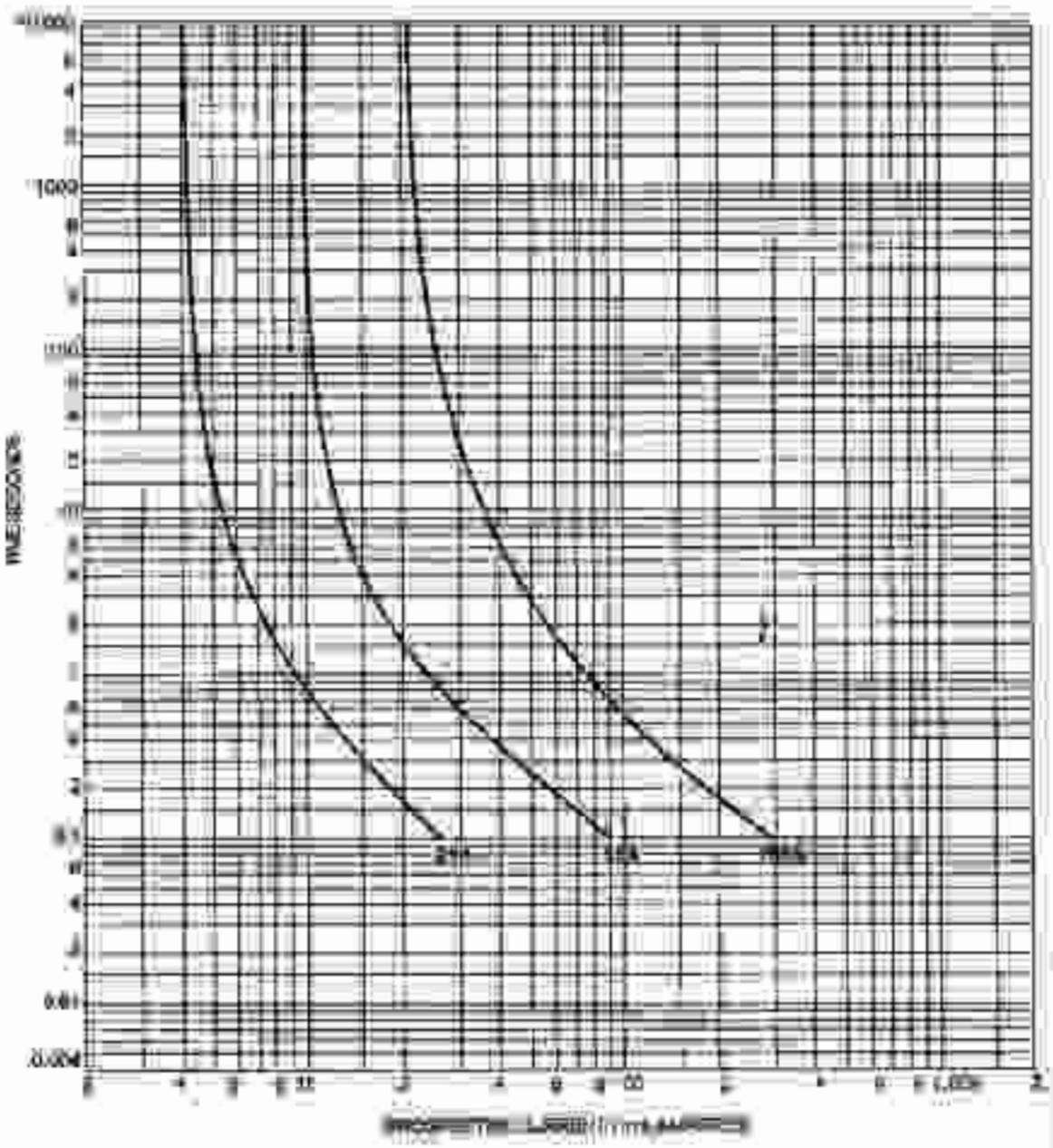

FUSE	CURRENT FOR TIME			
	0.1 SEC	1 SEC	10 SEC	100 SEC
10A	260A	180A	125A	90A
15A	800A	580A	390A	165A
20A	2600A	1800A	1200A	830A

Fig 20

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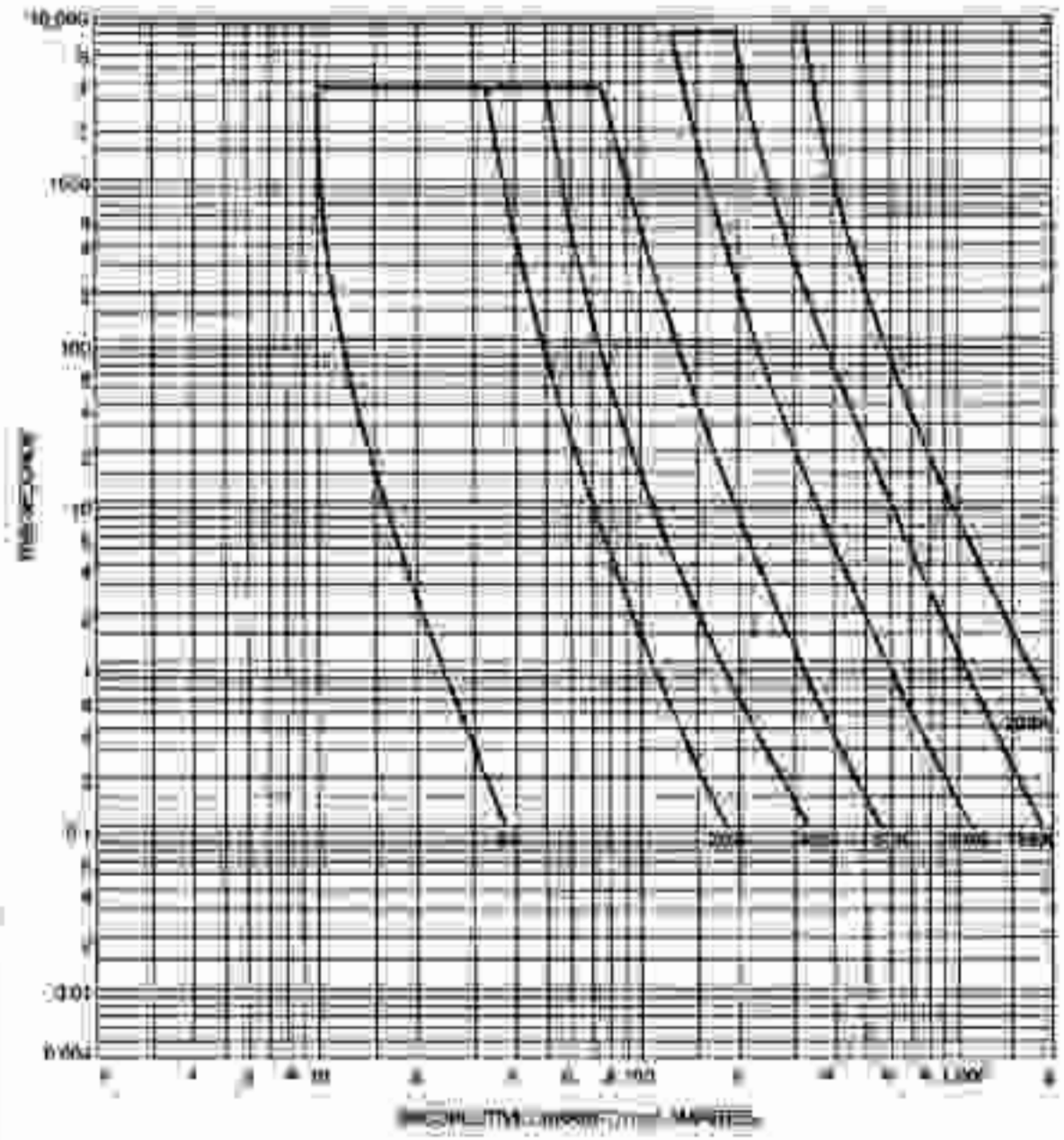

FUSE RATING	CURRENT FOR TIME			
	0.1sec	0.2sec	0.6sec	2sec
3A	32A	27A	23A	15A
20A	115A	150A	130A	79A
25A	230A	200A	220A	125A
50A	480A	550A	530A	300A
80A	1100A	890A	740A	480A
125A	1800A	1500A	1300A	950A
100A	3500A	3000A	2500A	1500A

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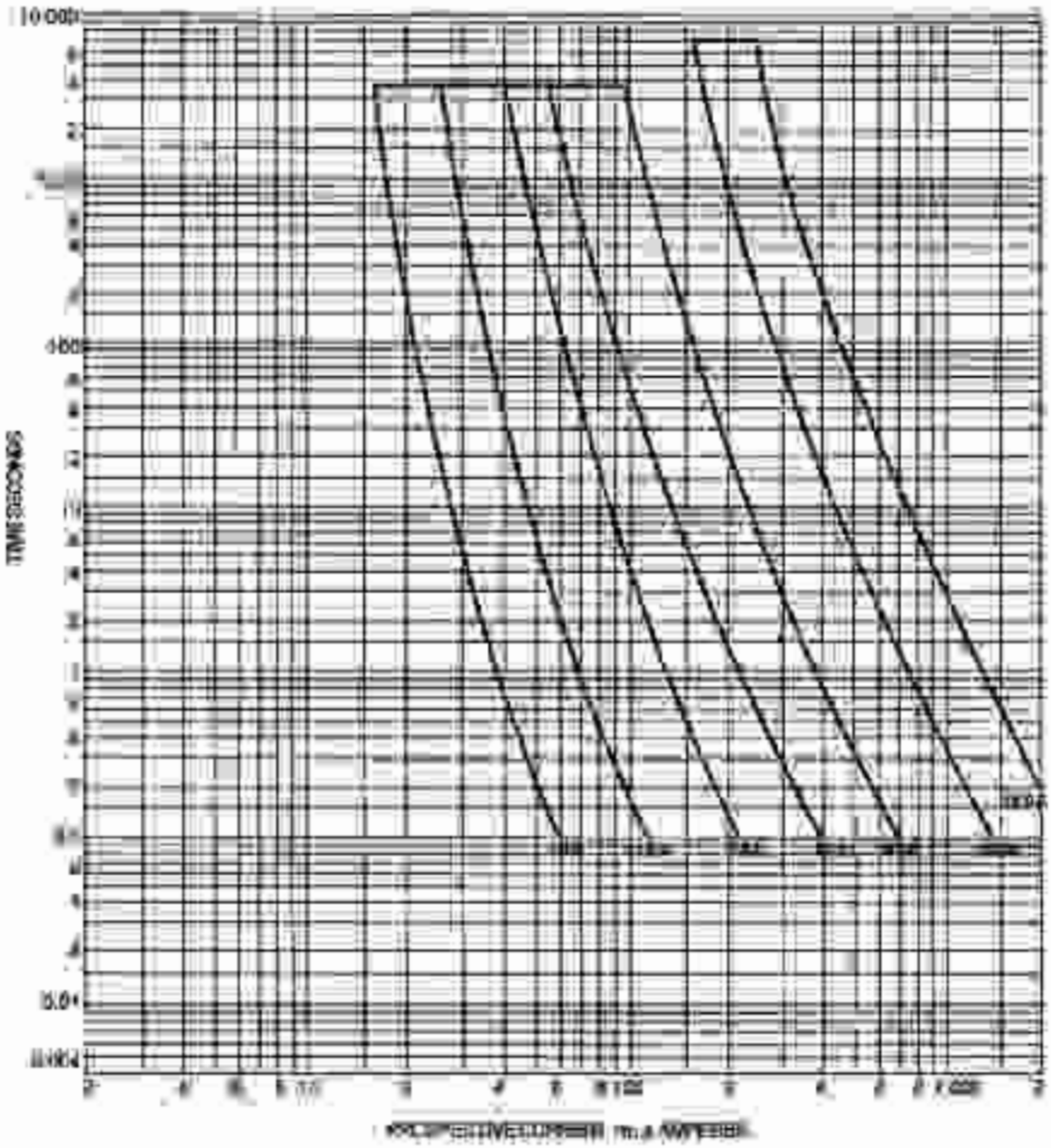

FUSE RATING	CURRENT FOR TIME			
	0.1sec	0.2sec	0.4sec	5sec
10A	300A	85A	45A	14A
15A	120A	95A	85A	55A
5A	220A	180A	150A	100A
30A	400A	300A	180A	130A
63A	710A	590A	500A	280A
100A	1300A	1150A	980A	650A
160A	1900A	2000A	1700A	1000A

Fig.-III

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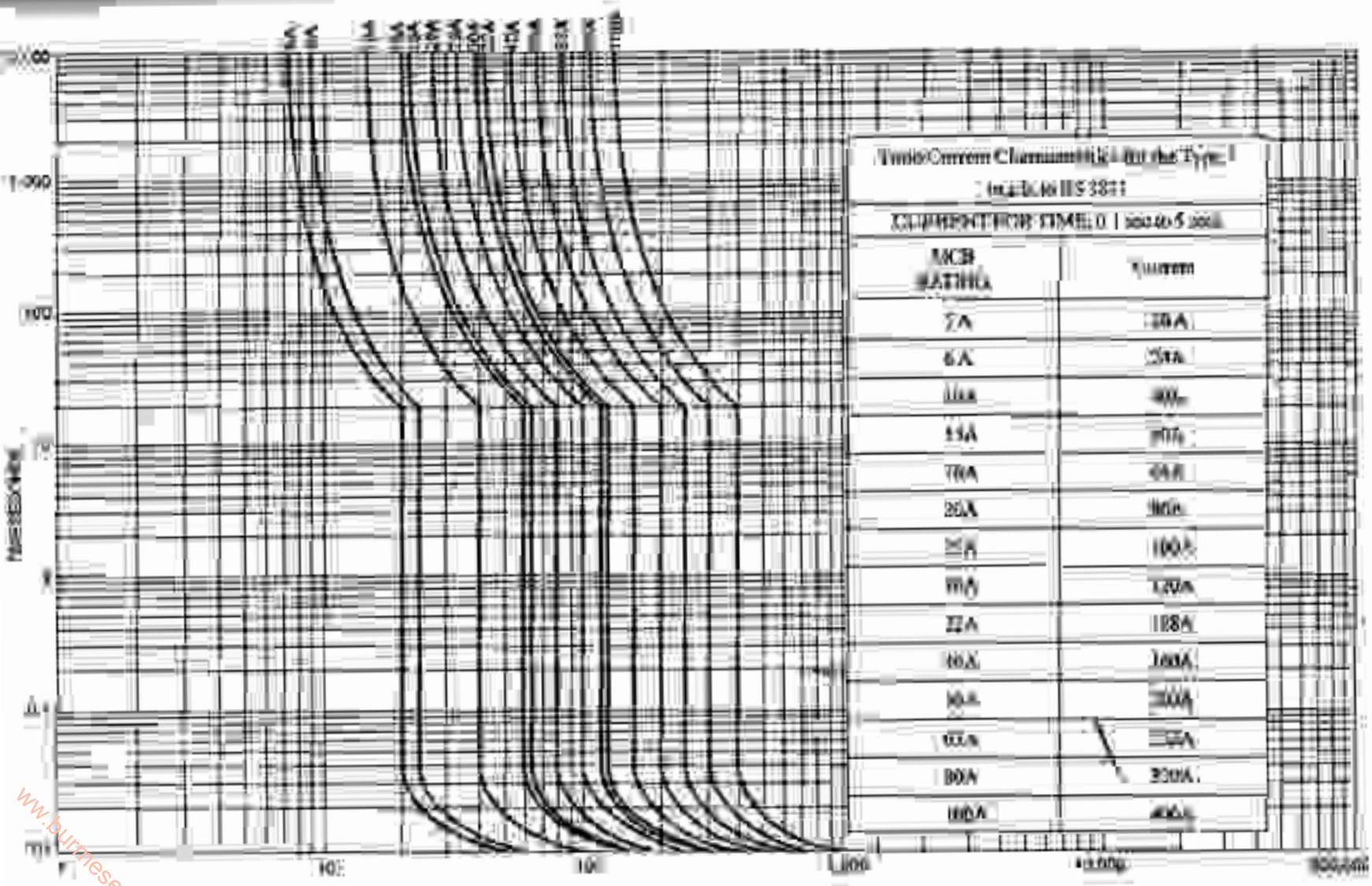

MCB RATING	Current
2A	10A
6A	30A
10A	50A
15A	75A
20A	100A
25A	125A
30A	150A
32A	160A
40A	200A
50A	250A
60A	300A
80A	400A
100A	500A

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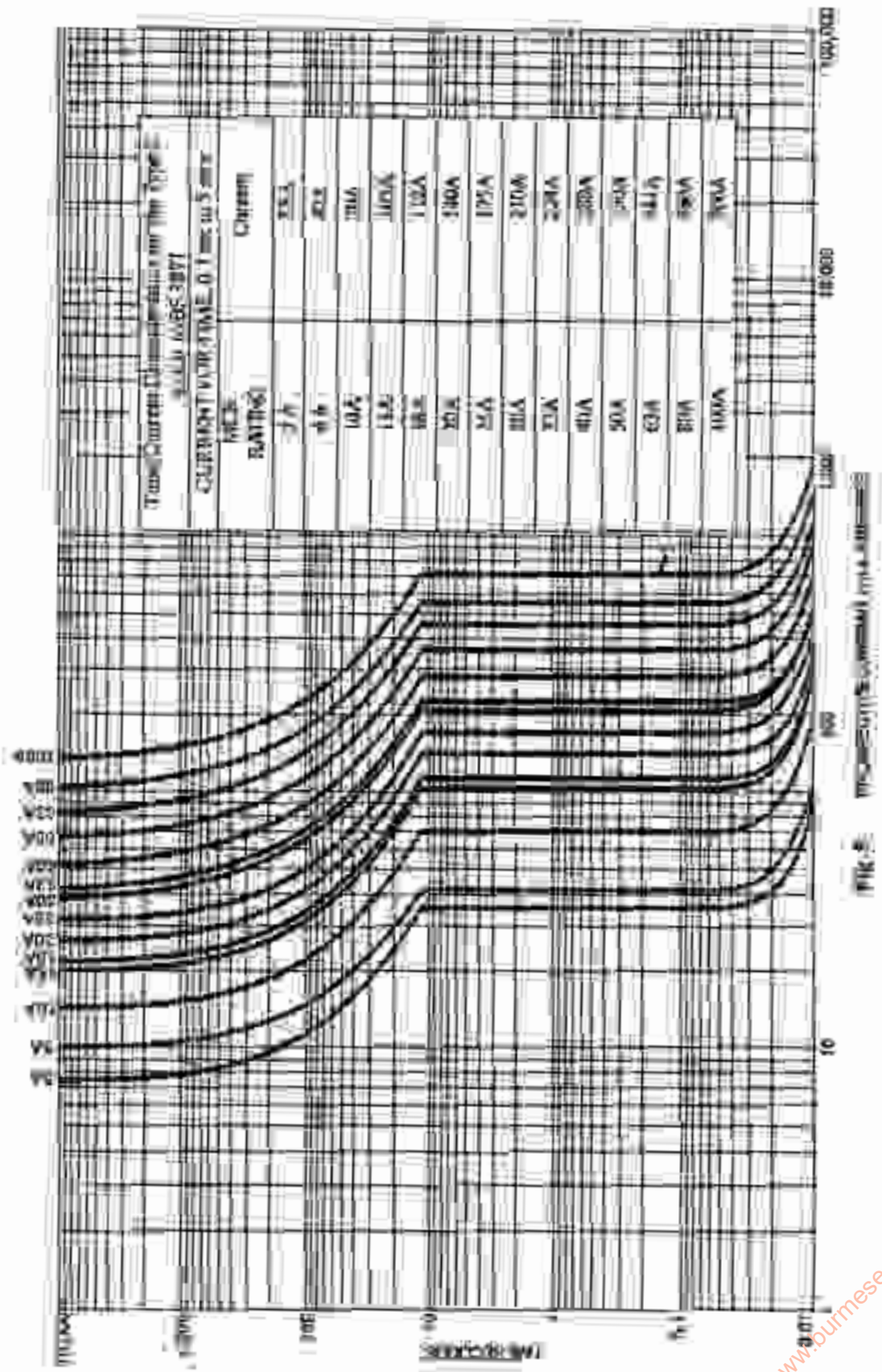

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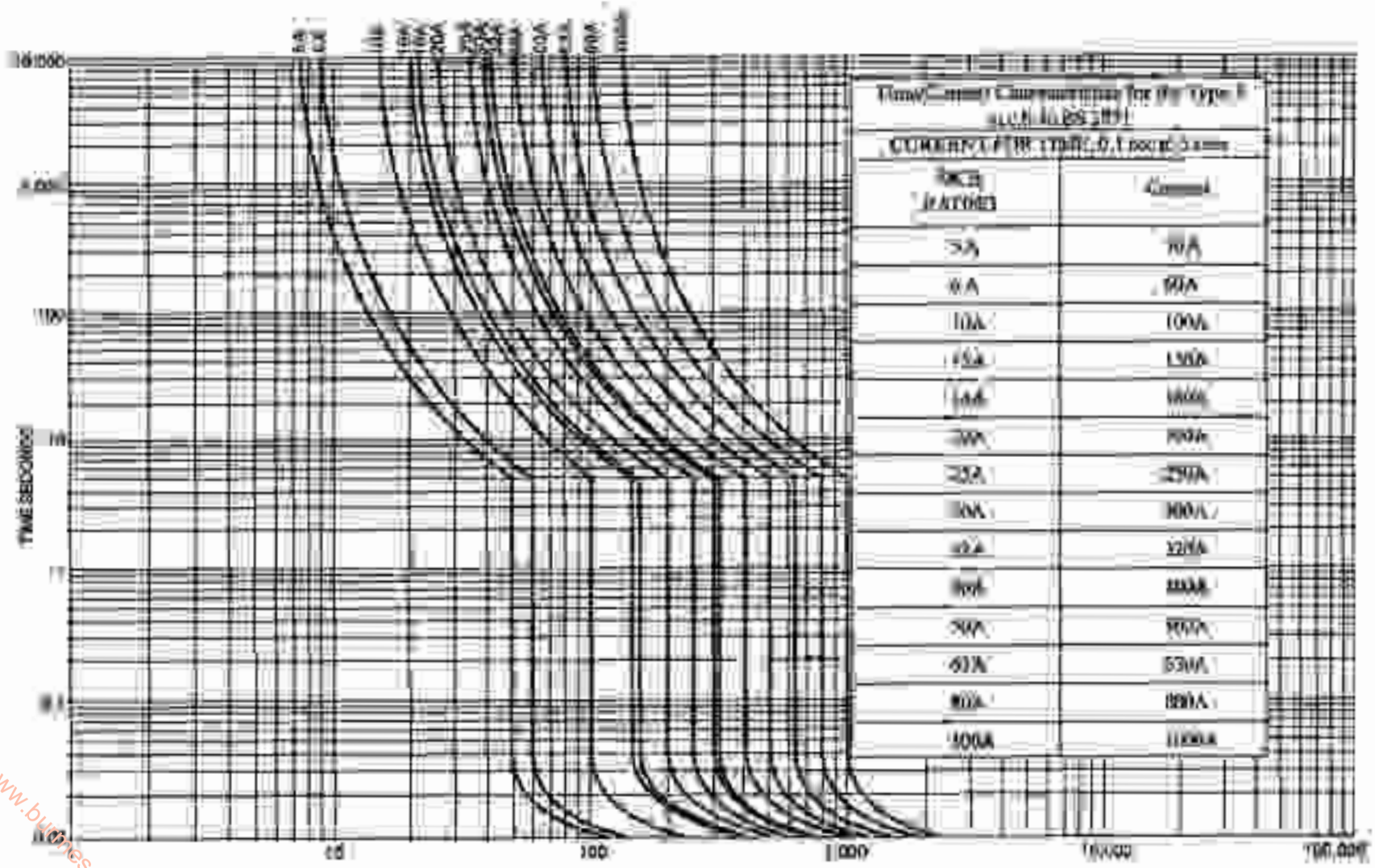

Fig. 6

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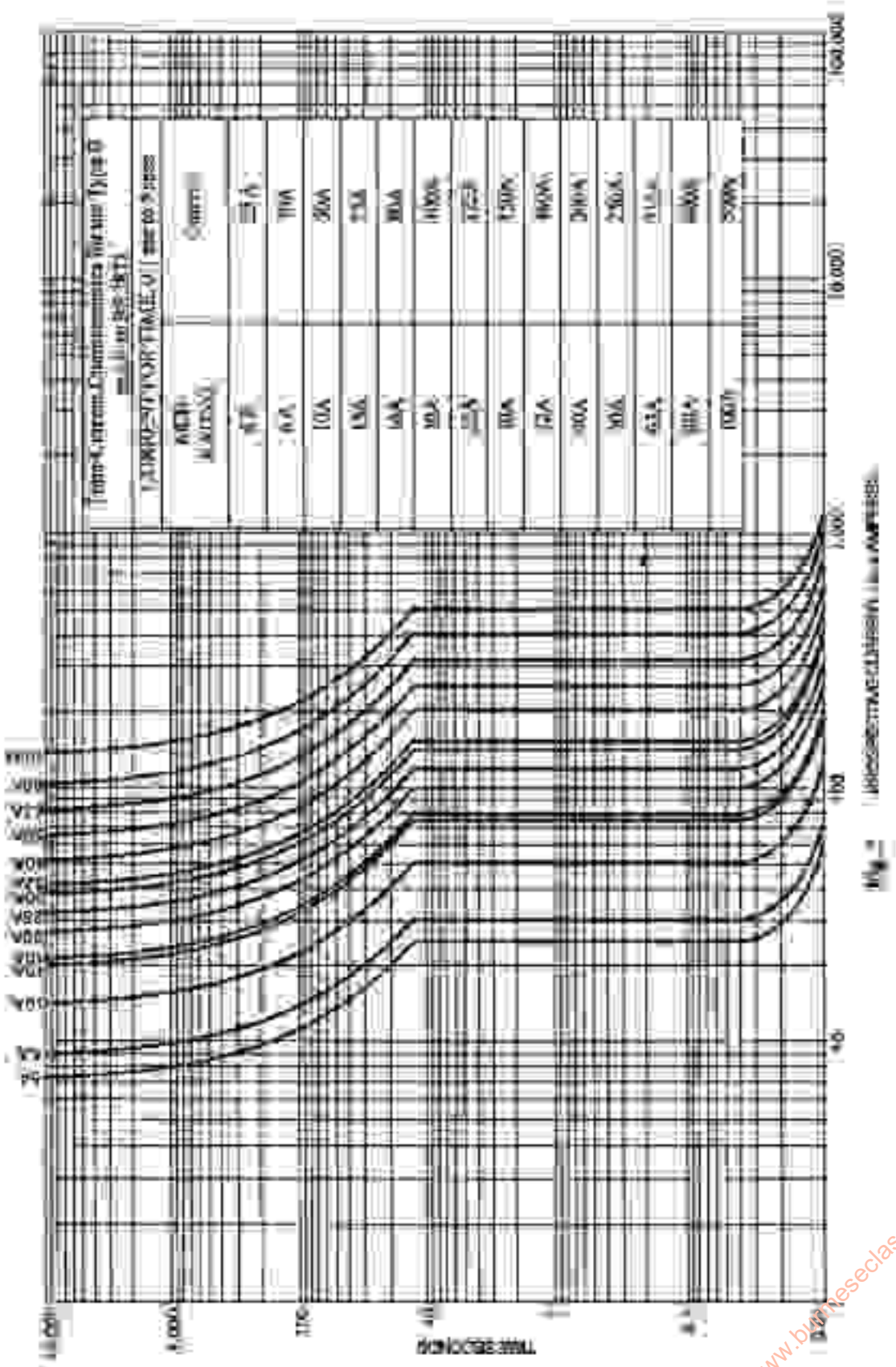

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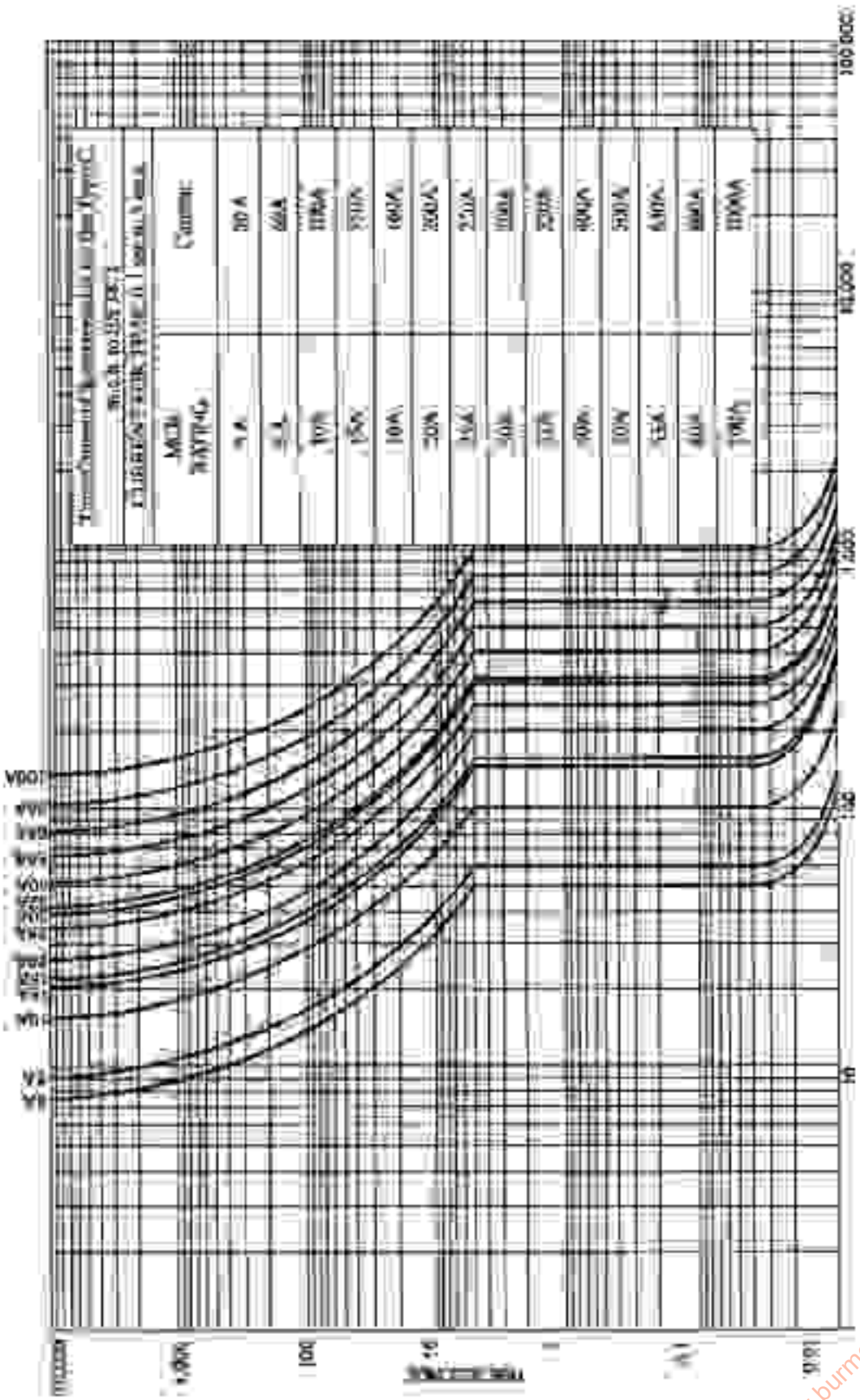

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APPENDIX 4

CURRENT-CARRYING CAPACITY AND VOLTAGE DROP FOR CABLE AND FLEXIBLE CORDS

cable [illegible] voltage drop
[illegible] TABLES [illegible] insulation [illegible]
cable [illegible]

COPPER CONDUCTORS

PVC-INSULATED CABLES

411 Single-core non-armoured, with or without sheath
412 Multicore non-armoured
413 Single-core armoured (non-magnetic armoured)
414 Multicore armoured

CABLES HAVING THERMOSETTING INSULATION

421 Single-core non-armoured, with or without sheath
422 Multicore non-armoured
423 Single-core armoured (non-magnetic armour)
424 Multicore armoured

BARE OR INSULATED CABLES

431 Single-core non-armoured
432 Multicore non-armoured

MINERAL INSULATED CABLES

441 Bare and exposed to touch, or bare, overall cover with p.v.c. for Reference Method 11
Bare and exposed to touch, or bare, overall covering of p.v.c. for Reference Method 11
Bare and exposed to touch, or having an overall covering of p.v.c. for Reference Method
11 and 13

442 Bare and neither exposed to touch nor in contact with combustible material for Reference Method 1
Bare and neither exposed to touch nor in contact with combustible materials for Reference Method 12 and 13

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TABLE 4E1A

Single-core 90°C thermoplastic insulated cables, non-armoured, with or without sheath

(COPPER CONDUCTORS)

CURRENT-CARRYING CAPACITY (Amperes)

Ambient temperature: 30°C

Conductor operating temperature: 70°C

TABLE 4D1B

Single-core p.v.c.-insulated cables, non-armoured, with or without sheath

BS 6004
BS 6231
BS 6346

VOLTAGE DROP (for ampere per metre)

Conductor operating temperature: 70°C

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TABLE 4J2A

Multicore PVC-insulated cables, non-armoured

(COPPER CONDUCTORS)

Ambient temperature: 30°C

CURRENT-CARRYING CAPACITY (Amperes)

Conductor operating temperature: 70°C

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TABLE 4D2H

Multicore p.v.c. insulated cables, non-armoured

(copper conductors)

BS 6004

BS 6346

VOLTAGE GRADE: [illegible] Conductor operating temperature: 70°C

Conductor nominal area	Two cores	Three cores, flat and touching			Three cores, trefoil		

TABLE 4D3A

Single-core armoured PVC insulated cables
(non-magnetic armour)
(COPPER CONDUCTORS)

3.3 kV

Ambient temperature: 30°C
Conductor operating temperature: 90°C

CURRENT-CARRYING CAPACITY (Amperes)

	Reference method [clipped direct]		Reference Method 1 [in a perforated cable tray]		Reference Method 4 [direct in ground]						
mm²	A	A	A	A	A	A	A	A	A	A	A
50	195	170	165	140	215	210	170	165	145	140	120
70	240	205	200	170	260	250	205	200	175	170	145
95	290	250	240	205	310	300	250	240	210	205	175
120	335	285	275	235	355	345	285	275	240	235	200
150	385	325	315	270	405	390	325	315	275	270	230
185	440	375	360	310	460	445	370	360	315	310	265
240	510	430	415	355	530	510	425	415	360	355	305
300	580	490	470	400	600	580	485	470	410	400	345
400	670	560	540	460	690	665	555	540	470	460	395
500	760	635	610	520	780	750	625	610	530	520	445
630	860	715	690	585	880	845	705	690	595	585	500
800	970	805	775	655	990	950	790	775	670	655	560
1000	1080	895	860	725	1100	1055	880	860	745	725	620

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TABLE 4D4A

Multicore armoured p.v.c. insulated cables

(COPPER CONDUCTORS)

(In air)

Ambient temperature: 30°C

CURRENT-CARRYING CAPACITY (Amperes) Conductor operating temperature: 70°C

Conductor area	Reference method 4 (clipped direct)		Reference method 11 (on a perforated horizontal or vertical cable tray, or ladder support)	
	Two loaded conductors	Three or four loaded conductors	Two loaded conductors	Three or four loaded conductors
mm²	A	A	A	A
1.5	24	21	27	24
2.5	32	28	37	32
4	42	37	49	42
6	54	48	63	54
10	73	66	86	75
16	98	88	115	100
25	129	117	149	127
35	158	144	185	158
50	191	175	225	192
70	245	224	289	246
95	299	274	352	298
120	344	317	410	346
150	392	364	473	399
185	448	419	542	456
240	528	497	641	538
300	608	581	741	621
400	726	699	892	741
500	844	821	1046	867
630	1000	986	1251	1038

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TABLE ID4D

Multicore armoured p.v.c. insulated cables

(copper conductors)

to 450

VOLTAGE DROP (per ampere per metre)

Conductor operating temperature 70°C

Current rating	Cross-sectional area of conductors	Three-phase a.c.	Single-phase a.c. or d.c.				
amperes	sq. mm.	mV			mV		

TABLE 4D5

70°C thermoplastic insulated and sheathed flat cable with protective conductor

(COPPER CONDUCTORS)

Ambient temperature: 30°C

Conductor operating temperature: 70°C

CURRENT-CARRYING CAPACITY (amperes)

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TABLE 4E1A

Single core cables, having thermosetting insulation, non-armoured, with or without sheath

(COPPER CONDUCTORS)

as laid

in air

Ambient temperature: 30°C

CURRENT CARRYING CAPACITY (Amperes) Conductor operating temperature: 90°C

Conductor cross sectional area	Reference Method A (enclosed in conduit in thermally insulating wall, etc.)		Reference Method B (enclosed in conduit on a wall or in trunking etc.)		Reference Method C (clipped direct)		Reference Method E (in free air or on a perforated cable tray horizontal or vertical)		Flat touching	Flat spaced	Flat spaced
	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.	3 or 4 cables, three-phase a.c.	2 cables, single-phase a.c. or d.c.	3 cables, three-phase a.c.	2 cables, single-phase a.c. or d.c.	2 cables, single-phase a.c. or d.c.	3 cables, three-phase a.c.
mm²	A	A	A	A	A	A	A	A	A	A	A
1	11	10	12	11	13	11	15.5	13	16.5	15	13
1.5	14	13	15.5	14	16.5	15	19.5	17.5	21	18.5	16.5
2.5	19.5	18	21	20	23	21	27	24	29	25	23
4	26	24	28	26	30	28	37	33	38	34	31
6	34	31	36	34	38	36	47	42	49	43	40
10	46	42	50	46	52	49	65	57	67	60	54
16	61	56	68	62	69	66	87	77	90	80	73
25	80	73	89	80	90	85	114	102	116	104	95
35	99	89	110	99	111	105	141	124	142	126	117
50	119	108	134	118	133	125	167	150	171	154	141
70	151	136	171	149	168	160	213	191	213	194	179
95	182	164	207	179	201	189	258	233	258	233	216
120	210	188	239	206	232	220	299	270	294	268	249
150	240	216	275	236	265	253	344	311	334	304	285
185	273	245	314	268	300	286	392	354	374	344	324
240	321	286	369	313	351	334	461	415	424	389	371
300	367	328	424	358	401	381	530	477	472	435	416
400	438	390	504	425	477	450	634	571	539	497	476
500	502	447	575	485	545	514	736	663	597	549	528
630	578	514	658	555	626	592	868	782	664	612	594
800	669	593	763	638	723	682	1005	906	740	682	667
1000	767	679	871	728	827	779	1149	1037	815	748	738

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TABLE 4E1B

Single-core cable having thermosetting insulation, non-armoured, with or without sheath

(copper conductors)

Conductor operating temperature: 90°C

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TABLE 4E1A

Multicore, non-armoured cable having thermoplastic insulation (COPPER CONDUCTORS) BS 5467

CURRENT-CARRYING CAPACITY (Amperes)

Ambient temperature: 30°C
Conductor operating temperature: 70°C

Conductor cross-sectional area	Reference Method 4 Clipped to a non-metallic surface		Reference Method 3 Bunched in conduit on a wall or other surface, or in trunking		Reference Method 1 (in thermal insulation)		Reference Method 1 (in free air)	
	Two-core cable, flat, touching	Three-core cable, flat, touching	Two-core cable	Three-core cable	Two-core cable	Three-core cable	Two-core cable	Three-core cable
1	2	3	4	5	6	7	8	9
mm²	A	A	A	A	A	A	A	A
1.0	17	15.5	15.5	14	12	11	19	17
1.5	20	18.5	19.5	17.5	15	13.5	24	21
2.5	27	25	26	24	20	18	32	28
4	37	34	36	32	28	25	42	36
6	47	43	46	41	36	32	54	46
10	65	60	63	57	50	44	73	63
16	87	80	85	76	66	59	98	85
25	114	101	112	96	84	73	129	112
35	141	126	138	119	104	90	158	138
50	167	153	168	144	125	110	198	168
70	215	196	213	184	160	140	245	213
95	264	238	258	223	194	170	292	258
120	308	276	299	259	225	197	344	299
150	356	319	344	299	260	227	391	344
185	409	364	392	341	297	259	448	392
240	485	430	461	403	351	305	528	461
300	561	497	530	464	402	351	608	530
mm²	A	A	A	A	A	A	A	A

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TABLE 4C2B

Multicore, unarmoured cable having thermosetting insulation

(Copper conductor)

up to 660

VOLTAGE DROP (per ampere per metre) Conductor operating temperature : 90°C

Nominal cross-sectional area of conductor	Cross-sectional area of copper	Terminal cable (mV/A/m)			Group of three cables laid flat touching (mV/A/m)		
mm²	mV/A/m						
		r	x	z	r	x	z
10	4.61	4.00	0.160	4.00	4.00	0.160	4.00
16	2.93	2.85	0.154	2.85	2.85	0.154	2.85
25	1.84	1.80	0.147	1.80	1.80	0.147	1.80
35	1.31	1.27	0.141	1.27	1.27	0.141	1.27
50	0.952	0.927	0.135	0.936	0.927	0.135	0.936
70	0.673	0.654	0.129	0.666	0.654	0.129	0.666
95	0.494	0.479	0.123	0.494	0.479	0.123	0.494
120	0.397	0.383	0.120	0.401	0.383	0.120	0.401
150	0.325	0.311	0.117	0.332	0.311	0.117	0.332
185	0.267	0.253	0.114	0.278	0.253	0.114	0.278
240	0.203	0.188	0.111	0.218	0.188	0.111	0.218
300	0.162	0.147	0.108	0.182	0.147	0.108	0.182
400	0.129	0.113	0.105	0.154	0.113	0.105	0.154
500	0.105	0.090	0.102	0.135	0.090	0.102	0.135
630	0.086	0.072	0.099	0.122	0.072	0.099	0.122

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TABLE 4E1A

Single-core cables having thermosetting insulation (non-magnetic armour)

COPPER CONDUCTORS

Ambient temperature: 30°C

Conductor operating temperature: 70°C

CURRENT-CARRYING CAPACITY (Amperes)

	Reference Method 1 (Clipped direct)		Reference Method 11 (On a perforated cable tray)		Reference Method 13 (Free air)						
Conductor cross-sectional area	Two loaded conductors, a.c. or d.c.	Three loaded conductors, a.c.	Two loaded conductors, a.c. or d.c.	Three loaded conductors, a.c.	Two loaded conductors, a.c. or d.c.		Three loaded conductors, a.c.		Two loaded conductors, a.c. or d.c.		Three loaded conductors, a.c.
	Touching	Touching	Touching	Touching	Touching	Spaced	Touching	Spaced	Touching	Spaced	Touching
mm²	A	A	A	A	A	A	A	A	A	A	A
1	2	3	4	5	6	7	8	9	10	11	12
1	11	11	12	12	15	16	13	14	17	18	15
1.5	14	14	16	15	19	20	17	18	22	23	19
2.5	20	18	21	20	26	28	23	25	30	31	26
4	26	24	28	26	35	38	31	33	40	42	35
6	34	31	36	33	45	49	40	43	51	54	44
10	46	42	49	45	63	67	54	59	70	75	61
16	61	56	66	61	81	87	73	79	94	100	81
25	80	73	87	80	107	115	95	105	125	133	108
35	99	89	109	98	133	143	117	130	154	164	135
50	119	108	130	117	160	172	141	157	187	198	164
70	151	136	164	147	204	220	179	200	238	253	207
95	182	164	197	177	246	264	216	242	289	306	251
120	210	188	227	204	285	307	249	281	335	354	292
150	240	216	259	233	324	348	285	320	382	402	335
185	273	245	295	266	370	396	324	365	435	455	382
240	321	286	346	312	435	464	380	430	510	532	453
300	367	328	396	356	497	529	435	492	584	606	523
400	438	390	472	424	593	630	519	587	703	723	626
500	502	447	542	485	686	721	603	680	823	844	737
630	578	514	624	559	790	826	695	785	946	966	855
800	669	593	723	643	912	948	800	901	1088	1104	985
1000	767	679	830	735	1044	1079	915	1035	1252	1262	1133

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TABLE 4D3B

single-core cable having thermosetting insulation (non-magnetic armour)

(copper conductor)

[illegible]

VOLTAGE DROP (per Ampere per metre)

Conductor operating temperature [illegible]°C

Conductor size	Weight (approx.)	Three single-core cables in trefoil touching			Three single-core cables in flat formation			Two single-core cables in flat formation			Three single-core cables in flat formation		
		Reference Method C (Clipped direct)			Reference Method B (In conduit on a wooden surface)			Reference Method C (Clipped direct)			Reference Method E (Free air)		
		a.c.		d.c.	a.c.		d.c.	a.c.		d.c.	a.c.		d.c.
mm²	kg/km	mV/A/m			mV/A/m			mV/A/m			mV/A/m		
		1	2	3	4	5	6	7	8	9	10	11	12
[illegible]													
[illegible]													
[illegible]													
[illegible]													
[illegible]													
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[illegible]													

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TABLE [illegible]

[illegible] armoured cables having thermosetting insulation

(COPPER CONDUCTOR)

[illegible] 5467

[illegible] 6724

Ambient temperature: 30°C

CURRENT CARRYING CAPACITY (Ampere) Conductor operating temperature: 90°C

Conductor area	[illegible]		[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]

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TABLE 4E4B

Multicore armoured cable having thermosetting insulation

(Copper conductor)

BS 5467, BS 6724

VOLTAGE 1900/ (per unpaired per earth): **Conductor operating temperature : 90°C**

Conductor nominal area	Reference method	Two loaded cables			Three loaded cables		

TABLE 4F1A

Single-core non-armoured rubber insulated 85°C rubber insulation /COPPER CONDUCTORS

Ambient temperature: 30°C

Conductor operating temperature: 85°C

CURRENT-CARRYING CAPACITY (Amperes)

TABLE 4(1)B

Single core, non-armoured cables having 85°C rubber insulation

copper conductors

1kV AC

or 1kV DC

VOLTAGE RATING (per conductor to conductor or conductor to earth):

Conductor operating temperature: 85°C

Cross-sectional area of conductor	Number and nominal diameter of wires in conductor	Reference method 1 (Enclosed in conduit in thermally insulating wall, etc.)	Reference method 11 (Clipped direct)	Reference method 12 (Ladder, cleats or similar)	Reference method 13 (Single-core cables, touching)	Reference method 14 (Single-core cables, spaced)	Reference method 15 (Free in air, spaced)	Reference method 16 (Free in air, touching)
mm²	mm	A	A	A	A	A	A	A
1	2	3	4	5	6	7	8	9
1	1/1.13	15	16	17	17	18	20	19
1.5	1/1.38	19	20	22	22	23	25	24
2.5	1/1.78	26	28	30	30	31	34	33
4	1/2.25	35	38	40	40	42	46	45
6	1/2.76	45	48	51	52	54	59	58
10	7/1.35	61	66	70	71	75	81	80
16	7/1.70	81	88	94	96	100	109	107
25	7/2.14	106	117	119	119	127	143	141
35	7/2.52	131	145	148	148	158	176	173
50	19/1.78	158	175	180	180	192	214	212
70	19/2.14	200	222	232	232	246	277	274
95	19/2.52	241	269	282	282	298	335	331
120	37/2.03	278	312	328	328	346	389	385
150	37/2.25	318	358	379	379	399	449	444
185	37/2.52	362	410	434	434	456	516	510
240	61/2.25	424	482	514	514	538	610	602
300	61/2.52	486	554	593	593	621	704	694
400	61/2.85	565	650	700	701	732	831	819
500	61/3.23	652	753	818	821	853	971	957
630	61/3.65	753	875	955	960	996	1135	1113

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TABLE 4F2A

Multicore, sheathed and non-armoured cables having 85°C rubber insulation

(COPPER CONDUCTOR)

BS 6883

Ambient temperature: 30°C

Conductor operating temperature: 85°C

CURRENT CARRYING CAPACITY (Amperes)

Conductor cross-sectional area	Reference method 4		Reference method 3		Reference method 1 (in conduit on a wall or in trunking)	
	Two cables, loaded, touching	Three cables, loaded, touching	Two cables, loaded	Three cables, loaded	Two cables, loaded	Three cables, loaded
mm²	A	A	A	A	A	A
1	15	13	16	14	14	12
1.5	19	16	20	17	18	15
2.5	26	22	28	24	25	21
4	35	30	38	33	33	28
6	45	38	49	42	43	36
10	63	53	67	58	59	50
16	85	71	91	77	79	66
25	112	96	120	102	104	89
35	138	117	148	125	129	109
50	168	143	180	154	157	134
70	213	183	232	198	202	171
95	258	223	282	241	246	208
120	299	259	328	280	285	242
150	344	299	379	324	330	279
185	392	341	434	371	375	317
240	461	403	514	439	443	375
300	530	464	593	508	510	432

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TABLE 4D2B

Multicore, sheathed and non-armoured cables having 85°C rubber insulation
(copper conductors)
BS 6883

VOLTAGE RATING (for copper per metre) **Conductor operating temperature 85°C**

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TABLE 4D1A

Mineral insulated cables, bare and exposed to touch or having an overall covering of p.v.c.

(COPPER CONDUCTORS AND SHEATH)

BS 6207

Ambient temperature: 30°C

CURRENT-CARRYING CAPACITY (Amperes) Sheath operating temperature: 70°C

REFERENCE METHOD

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TABLE 4J1A (continued)

Mineral insulated cable bare and exposed to touch or having an overall covering of p.v.c. (COPPER CONDUCTORS AND SHEATH)

BS 6207

CURRENT-CARRYING CAPACITY (Amperes)

Ambient temperature 30°C

Sheath operating temperature 70°C

REFERENCE METHOD 11 (on a ventilated cable tray horizontal or vertical)

Conductor cross-sectional area	Two loaded conductors	Three loaded conductors	Two loaded conductors	Three loaded conductors	Two loaded conductors	Three loaded conductors	Two loaded conductors	Three loaded conductors	Two loaded conductors	Three loaded conductors	Two loaded conductors	Three loaded conductors
	Touch	Touch	Bare and exposed to touch	Bare and exposed to touch	Touch	Touch	Bare and exposed to touch	Bare and exposed to touch	Touch	Touch	Bare and exposed to touch	Bare and exposed to touch
	Vertical	Vertical	Vertical	Vertical	Horizontal	Horizontal	Horizontal	Horizontal	Trefoil	Trefoil	Trefoil	Trefoil
mm²	A	A	A	A	A	A	A	A	A	A	A	A
1	18	17	19	18	19	18			16	15	17	16
1.5	23	21	24	22	24	22			21	19	22	20
2.5	31	29	33	30	32	30			29	27	30	28
4	41	38	43	40	42	39			38	35	40	36
6	53	49	57	52	55	51			49	46	52	48
10	74	68	78	71	75	70	83	76	67	62	71	65
16	98	91	104	96	100	93	110	102	90	84	96	88
25	132	123	138	127	133	124	146	136	120	111	127	117
35	161	150	168	155	164	152	182	169	148	138	157	145
50	198	185	205	190	201	187	219	204	180	168	191	177
70	253	236	261	242	258	240	279	259	232	216	246	228
95	306	285	315	293	311	289	334	309	282	262	299	277
120	354	329	364	338	360	335	386	358	328	305	348	323
150	407	379	419	388	413	385	441	410	379	353	402	374
185	464	433	479	444	471	439	503	468	434	404	460	428
240	546	510	565	525	554	516	595	553	514	479	544	508
300	629	587	651	605	637	594	684	637	593	554	628	587
400	754	702	780	724	762	709	819	761	709	661	751	701
500	868	807	898	831	875	813	938	871	813	755	861	800
630	1005	933	1039	961	1010	937	1082	1004	939	870	994	922
800	1158	1073	1196	1105	1162	1076	1243	1149	1076	994	1140	1053
1000	1338	1237	1378	1272	1341	1239	1428	1317	1239	1142	1311	1208

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TABLE 4I1A (continued)

Mineral insulated cables bare and exposed to touch or having an overall covering of p.v.c.

(COPPER CONDUCTORS AND SHEATH)

BS 6207

Ambient temperature 30°C

CURRENT-CARRYING CAPACITY (Amperes) Sheath operating temperature 70°C

METHOD OF INSTALLATION

Nominal cross-sectional area	Two loaded conductors	Three or four loaded conductors	One loaded conductor	One cable all cores loaded	One cable all cores loaded	Two cables all cores loaded	Three cables all cores loaded	Three-phase a.c. or single-phase d.c. Vertical	Horizontal	Flat touching
	A	A	A	A	A	A	A	A	A	A

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TABLE XIII

Mineral insulated cables bare and exposed to touch or having an overall covering of p.v.c.

(COPPER CONDUCTORS AND SHEATH)

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TABLE 4.11B (Continued)

Mineral insulated cables, bare and sheathed or unsheathed, suitable for use at voltages not exceeding 600/1000 V, having COPPER CONDUCTORS AND SHEATH

IS: 8307

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TABLE 4D2A

Mineral insulated cable bare and neither exposed to touch nor in contact with combustible material.
(COPPER CONDUCTORS AND SHEATH)
BS 6207

CURRENT CARRYING CAPACITY (Amperes)

Ambient temperature: 30°C
Sheath operating temperature: 70°C

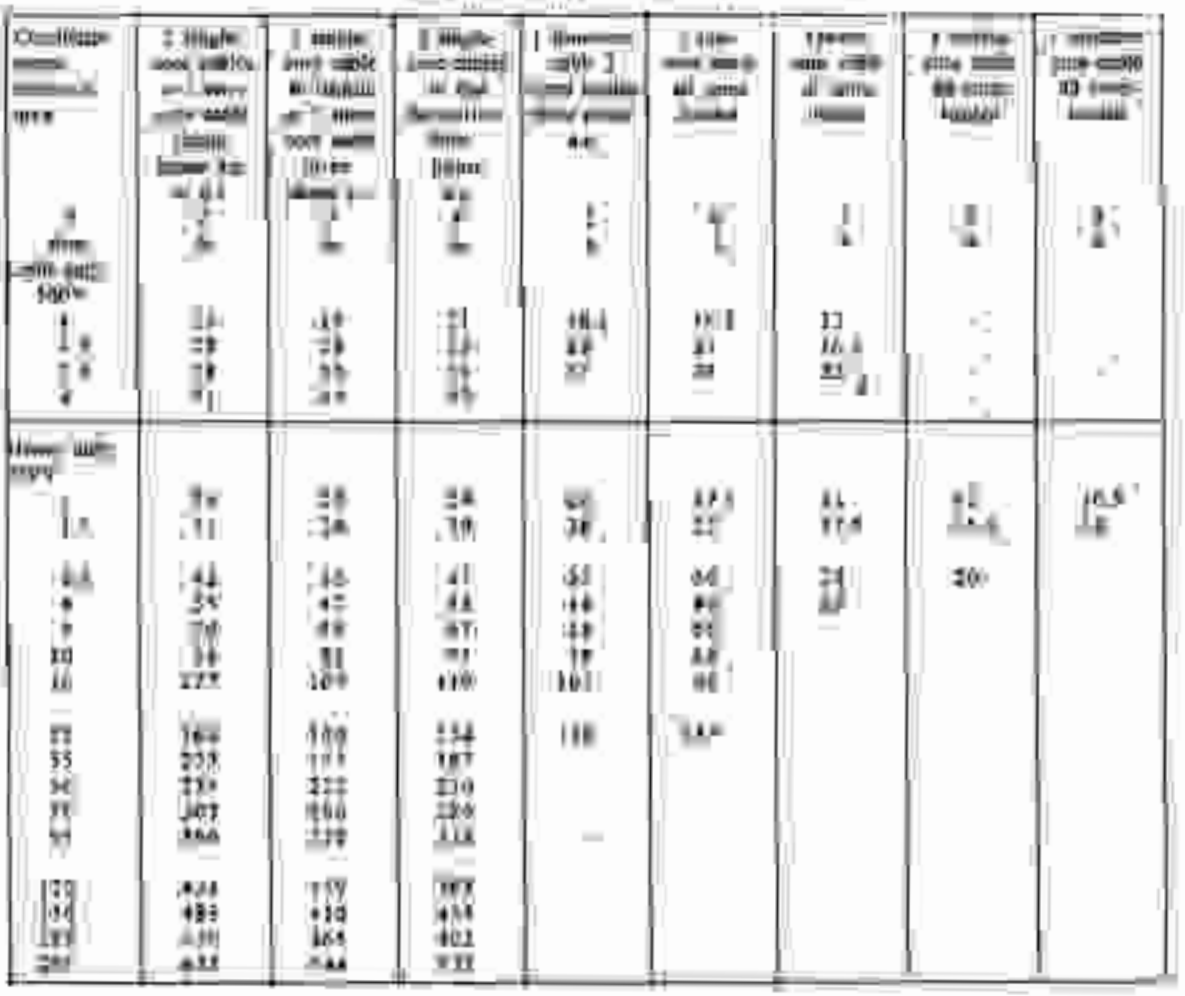

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TABLE 4J3A(cont)

Sheathed insulated cables here and neither exposed to touch not in contact with combustible material (COPPER CONDUCTORS AND RELATED) BS 6207

CURRENT-CARRYING CAPACITY (Amperes)

Ambient temperature: 30°C
Sheath operating temperature: 90°C

REFERENCE METHODS 11 AND 13 (BS 7671)

Conductor cross-sectional area	Two loaded conductors, touching, clipped direct, (Reference Method 11)	Two loaded conductors, touching, on a perforated cable tray horizontal or vertical, (Reference Method 13)	Two loaded conductors, touching, in conduit on a wall or in trunking (Reference Method 11)	Two loaded conductors, touching, in conduit in an insulating wall, (Reference Method 11)	Two loaded conductors, touching, in conduit in a thermally insulating wall, (Reference Method 11)	Two loaded conductors, touching, in conduit in an insulating wall, (Reference Method 11)	Two loaded conductors, touching, in conduit in a thermally insulating wall, (Reference Method 11)	Two loaded conductors, touching, clipped direct, (Reference Method 11)	Two loaded conductors, touching, on a perforated cable tray horizontal or vertical, (Reference Method 13)	Two loaded conductors, touching, in conduit on a wall or in trunking (Reference Method 11)
1	10	11	11	11	14	11	14	17	18	19
mm²	A	A	A	A	A	A	A	A	A	A
Copper										
70V										
1	24	31	30	18	14			30	30	31
1.5	31	36	36	23	18			33	39	38
2.5	41	50	49	32	25			45	49	50
4	55	66		42	33			60	65	68
Heavy duty										
6	68	82	80	54	43	52	41	78	84	86
10	92	109	107	73	59		56	105	113	115
16	124	147	138	98	79	88		140	150	152
25	161	190	171	129	104	114		182	195	197
35	201	238	209	158	129	143		228	246	247
50	243	286	269	191	155	174		273	294	298
70	297	350	328	245	200	221		336	363	366
95	362	426	400	302	245	270		410	441	445
120	414	490	455	347	284	309		469	506	510
150	473	556	520	395	323	353		532	574	579
185	542	637	594	452	371	406		609	657	663
240	641	754	702	535	439	480		721	778	784
300	741	868	806	617	508	554		833	896	903

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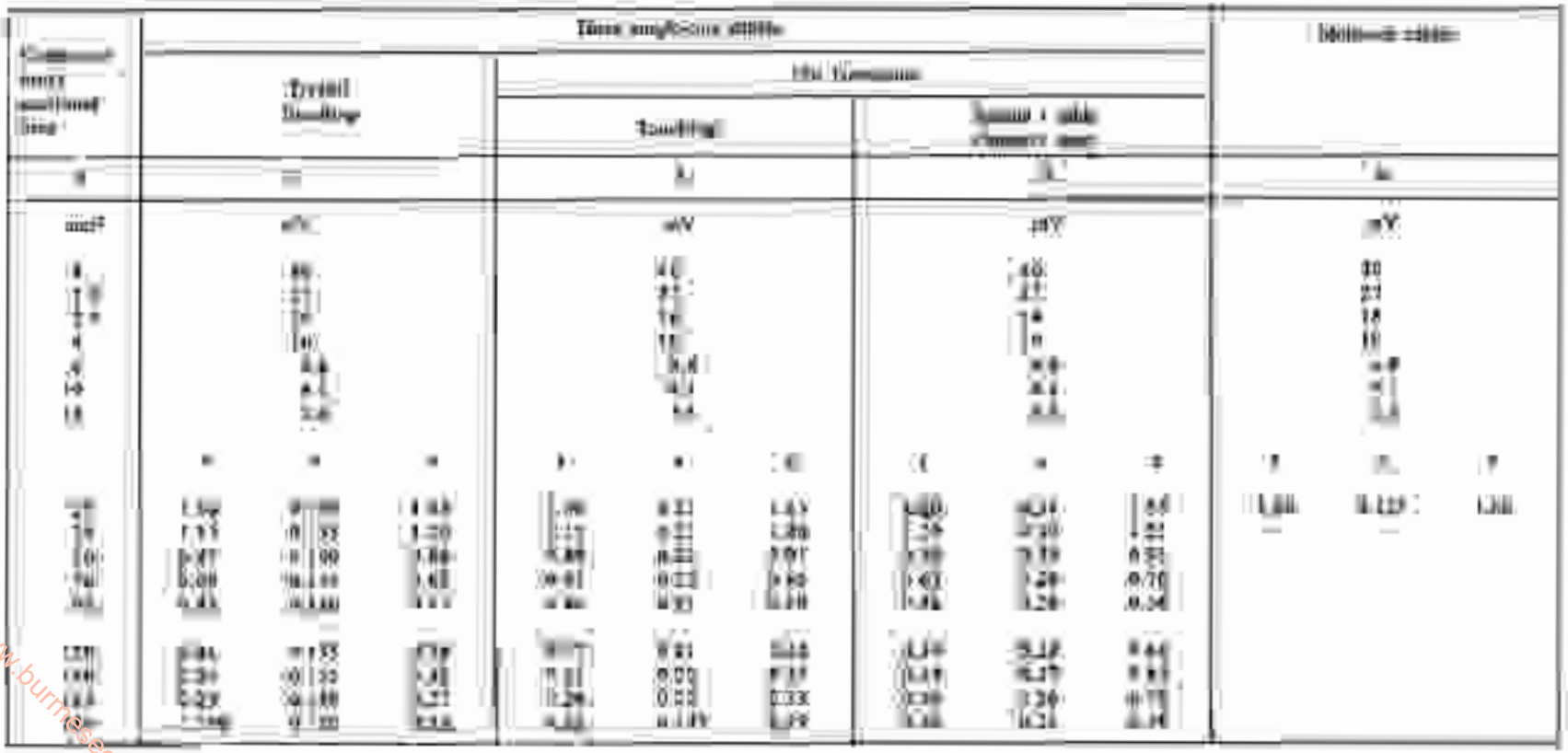
TABLE 52B

Mineral insulated cables bare and neither exposed to touch nor in contact with combustible materials
(COPPER CONDUCTORS AND SHEATH)
BS 6207

TABLE 4J2B (Continued)

Mineral insulated cable having one surface exposed to touch
and in contact with combustible material
(COPPER CONDUCTORS AND SHEATH)
BS 6207

VOLTAGE DROP (per ampere per metre) for three-phase operation: Sheath operating temperature: 105°C



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APPENDIX 4

Symbols

The symbols used in this book are generally aligned with those used in BS 7671 together with some additional symbols which have been found necessary.

Symbols used infrequently are defined where they occur in the text.

C_a correction factor for ambient temperature

C_c correction factor for type of overcurrent protective device

$C_c = 1$ for HBC fuses and mcbs

$C_c = 0.725$ for semi-enclosed fuses

C_g correction factor for grouping

C_i correction factor for conductor embedded in thermal insulation

C_r correction factor for grouping of ring circuits

d circuit route length, m

I_b design current of circuit, A

I_{dn} rated residual operating current of an rcd, mA (or A)

I_f earth fault current, A

I_n nominal current of protective device, A

I_{sc} short circuit current, A

I_t required tabulated current-carrying capacity, A (ခြေခံအားဖြင့်)

I_z actual tabulated current-carrying capacity, A (ခြေခံအားဖြင့် မည်သည့်အခြေအနေအောက်တွင်)

$I_{z'}$ current used as a basis for calculating the required current-carrying capacity of the live conductors, A (Circuit အားလုံးအတွက် ကျော့ကွင်းပြင်ဆင်မှုများ၊ ပုံစံများ ပြောင်းလဲမှုများ အတွက်)

$I_{z''}$ effective current-carrying capacity, A (ခြေခံအားဖြင့် မည်သည့်အခြေအနေအောက်တွင် အသုံးပြုမည်ကို ဆုံးဖြတ်)

S conductor cross-sectional area, mm²

t_a actual or expected ambient temperature, °C

t_c maximum permitted conductor temperature under overload conditions, °C

t_n maximum permitted normal operating conductor temperature, °C

t_r reference ambient temperature, °C – (IEE BS7671 is 30°C)

t_s actual conductor operating temperature, °C

U_o nominal voltage, V

U nominal voltage line to line, V

U_o nominal phase voltage, V

Z_1 impedance of live conductor, ohm

$= \sqrt{(R_1^2 + X_1^2)}$ where R_1 is the resistance component and X_1 is its reactance component

Z_2 impedance of protective conductor, ohm

$= \sqrt{(R_2^2 + X_2^2)}$ where R_2 is the resistance component and X_2 is its reactance component

Z_e sum part of the earth fault loop impedance which is external to the installation, ohm

Z_s phase to neutral impedance, ohm

Z_s earth fault loop impedance, ohm

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DEFINITIONS

The following definitions of terms used in this book have been aligned, as well as without modification, with the definitions in BS 7671 : 1992.

Ambient temperature
The temperature of the air or other medium where the equipment is to be used.
(Formerly called external influence)

Bonding conductor
A protective conductor providing equipotential bonding.

Bunched
Cables are said to be bunched when more than one are contained within a single conduit, duct, trunking or ducted, or not separated from each other by a specified distance.

Circuit protective conductor (cpc) (circuit earth)
A protective conductor connecting exposed conductive parts of equipment to the main earthing terminal (sometimes referred to as the earth bar) so that they are connected to the earth for the protective device.

Current-carrying capacity of a conductor
The maximum current which can be carried by a conductor under specified conditions without its steady state temperature exceeding a specified value.

Design current (of a circuit)
The magnitude of the current (rms value for a.c.) to be carried by the circuit in normal service.

Direct contact
Contact of persons or livestock with live parts.

Distribution circuit
A final circuit connecting the origin of the installation to
- an item of switchgear or
- an item of control gear or
- a distribution board

to which one or more final circuits or items of current-using equipment are connected (see also definitions for final circuit). A distribution circuit may also connect the origin of an installation to an outlying building in a separate installation, when it is sometimes called a sub-main.

Earth fault current
A fault current which flows to earth.

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Earth fault loop impedance

The impedance of the earth fault current loop starting and ending at the point of earth fault. This impedance is denoted by Z_s.

The earth fault loop comprises the following, starting at the point of fault:

- the circuit protective conductor
- the consumer's earthing terminal and earthing conductor
- for TN systems, the metallic return path
- for TT and IT systems, the earth return path
- the path through the earthed neutral point of the supply transformer and the transformer winding
- the phase conductor from the transformer to the point of fault.

Earth leakage current

A current which flows to earth, or extraneous-conductive-parts, in a circuit which is electrically sound. This current may have a capacitive component including that resulting from the deliberate use of capacitors.

Earthing

Connection of the exposed-conductive-parts of an installation to the main earthing terminal of that installation.

Earthing conductor

A protective conductor connecting the main earthing terminal of an installation to an earth electrode or to other means of earthing. (ဤစနစ်သည် မြေကြီးအဆက်အသွယ်ကို မြေကြီးပေါ်ရှိ ကိရိယာများနှင့် ဆက်သွယ်ပေးသည်)

Equipotential bonding

Electrical connection maintaining various exposed-conductive-parts and extraneous-conductive-parts at substantially the same potential. (မြေကြီးအားသွင်းခြင်းစနစ်သည် ပေါက်ကွဲနိုင်သော ဓာတ်ငွေ့များ ရှိနေသည့်နေရာများတွင် ဓာတ်ငွေ့များ ပေါက်ကွဲခြင်းမှ ကာကွယ်ပေးသည်)

Exposed-conductive-part

A conductive part of equipment which can be touched and which is not a live part but which may become live under fault condition. (ပြင်ပမှ ထိတွေ့နိုင်သော ပစ္စည်းများ)

External influence

Any influence external to an electrical installation which affects the design and safe operation of that installation.

Extraneous-conductive-part

A conductive part liable to introduce a potential, generally earth potential, and not forming part of the electrical installation. (လျှပ်စီးကြောင်းစီးဆင်းနိုင်သော ပစ္စည်းများ)

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Fault current
A current resulting from an insulation failure or the bridging of insulation.
(Cable တွေရဲ့ insulation ပျက်စီးမှုကြောင့် ဖောက်ထွင်းစီးဆင်းသွားတဲ့ current ကို ဆိုလိုပါတယ်။ ဒီလို current မျိုးကို earth fault current, short circuit current လို့ ခေါ်ဆိုကြပါတယ်။)

Final circuit
A circuit connected directly to current-using equipment, or to a socket-outlet or socket-outlets, or other outlet points for the connection of such equipment. (လျှပ်စစ်ပစ္စည်းတွေကို တိုက်ရိုက်ချိတ်ဆက်ထားတဲ့ circuit ဖြစ်ပါတယ်။ ဒီ circuit မှာ socket တွေ၊ outlet တွေ ပါဝင်ပါတယ်။ ဒီ circuit ကို final circuit လို့ ခေါ်ပါတယ်။)

Indirect contact
Contact of persons or livestock with exposed-conductive-parts which have become live under fault conditions. (လျှပ်စစ်ပစ္စည်းတွေရဲ့ exposed-conductive-parts တွေဟာ fault ဖြစ်ပြီး live ဖြစ်သွားတဲ့အခါ လူတွေ၊ တိရစ္ဆာန်တွေဟာ ဒီ exposed-conductive-parts တွေနဲ့ တိုက်ရိုက်ထိတွေ့ခြင်းကို indirect contact လို့ ခေါ်ပါတယ်။)

Live parts
A conductor or conductive part intended to be energized in normal use, including a neutral conductor but, by convention, not a PEN conductor.

Main earthing terminal
The terminal or bar provided for the connection of protective conductors, including equipotential bonding conductors, and conductors for functional earthing, if any, to the means of earthing.

Origin of an installation
The position in which electrical energy is delivered to an electrical installation.

Overcurrent
A current exceeding the rated value. For conductors the rated value is the current-carrying capacity

Overload current
An overcurrent occurring in a circuit which is electrically sound

PEN conductor
A conductor combining the functions of both protective conductor and neutral conductor.

Protective conductor
A conductor used for some measures of protection against electric shock and intended for connection together any of the following parts:
exposed-conductive-parts
extraneous-conductive-parts
the main earthing terminal
earth electrode(s)
the earthed point of the source, or an artificial neutral.

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Residual current
The algebraic sum of the currents flowing in the live conductors of a circuit at a point in the electrical installation.

Residual current device
A mechanical switching device or association of devices intended to cause the opening of the contacts when the residual current attains a given value under specified conditions.

Residual operating current
Residual current which causes the residual current device to operate under specified conditions.

Ring final circuit
A final circuit arranged in the form of a ring and connected to a single pole of supply.

Short-circuit current
An overcurrent resulting from a fault of negligible impedance between live conductors having a difference in potential under normal operating conditions.

System
An electrical system consisting of a single source of electrical energy and an installation. For certain purposes (of the Wiring Regulations), types of system are identified as follows, depending upon the relationship of the source, and of exposed-conductive-parts the installation, to Earth:

- *TN system*, a system having one or more points of the source of energy directly earthed, the exposed-conductive-parts of the installation being connected to that point by protective conductors.
- *TN-C system*, in which neutral and protective functions are combined in a single conductor throughout the system.
- *TN-S system*, having separate neutral and protective conductors throughout the system.
- *TN-C-S system*, in which neutral and protective functions are combined in a single conductor in part of the system.
- *TT system*, a system having one point of the source of energy directly earthed, the exposed-conductive-parts of the installation being connected to earth electrodes electrically independent of the earth electrodes of the source.
- *IT system*, a system having no direct connection between live parts and earth, the exposed-conductive-parts of the installation being earthed.

Voltage, nominal
Voltage by which an installation (or part of an installation) is designated. The following categories of nominal voltage (rms values for a.c.) are defined:

- *Extra-low*. Normally not exceeding 50V a.c. or 120 V ripple free d.c., whether between conductors or to earth.
- *Low* (formally standing estimate voltage not exceeding 1000 V a.c. or 1500 V d.c. between conductors, or 600 V a.c. or 900 V d.c. between conductors and earth).

The actual voltage of the installation may differ from the nominal value by a quantity within normal tolerances.

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ကြိုတင်ပိတ်ထားရသော အချက်အလက်များ

(၁) R_p = အဆက်ချို့ ခုခံမှုအား phase ကြိုး

R_e = အဆက်ချို့ အသုံးပြုသော circuit earth ကြိုး

circuit earth ကြိုး = အဆက်ချို့တွင်ပေးသော conductor (တစ်ခု)

= အဆက်ချို့ပတ်ဝန်းကျင်ရှိ (ငှါး)

= ကုမ္ပဏီပိုင် earth (ငှါး)

= ကြိုးတစ်ခုတည်း သို့မဟုတ် ကြိုးများစွာကို ပေါင်းစပ်ထားသော ကြိုးတန်းများ ဖြစ်ပြီး ကြိုးတန်းများသည် ကုမ္ပဏီပိုင်ဧရိယာအတွင်း၌ earth နှင့် ဆက်သွယ်ထားသော ကြိုးများ ဖြစ်သည်။

R_e = ကြိုးတန်း၏ ခုခံမှုအား ohms ဖြင့်

$R_1 = R_2$ = circuit earth fault loop impedance

$R_1 = R_2$ = circuit short-circuit impedance

Z_e = external earth fault loop impedance

Z_{ze} = (external) zero-circuit impedance

ဤ circuit တစ်ခု တည်ဆောက်ပြီးသည်နှင့် ဖြစ်နိုင် fault current များ သွားလာစေသည့် main fuse တို့ဖွင့် သော်လည်း ဖြစ်နိုင် less circuit are external power supply circuit နှင့်စပ်လျဉ်း၍ ထို main ကြိုးများ ဆက်သွယ်ထားသော ဝိုင် circuit are သွားလာစေသည့် ကြိုး circuit ၏ ကြိုးတန်းများအား main fault loop impedance ဟု external earth fault loop impedance ဟုလည်း တစ်ခုခု ဖြစ်ပေါ်ပြီး circuit ၏ ကြိုးတန်းများအား short-circuit impedance ဟု (external) short-circuit impedance ဟုလည်း ခေါ်ဆိုသည်။

Z_s = total earth fault loop impedance

= $Z_e + (R_1 + R_2)$

Z_s = total short-circuit impedance

= $Z_{ze} + (R_1 + R_2)$

I_a = actual industrial current-carrying capacity

= ကြိုး၏ ကြိုးမှ လျှပ်စီးကို သယ်ဆောင်နိုင်သော စွမ်းရည်

= ကြိုးမှ current ကို ဘေးကင်းစွာ သယ်ဆောင်နိုင်သော ကြိုး၏ current carrying capacity ကို I_a ဟုခေါ်ဆိုပြီး ကြိုးတစ်ခုအတွင်း I_a နှင့် ဆက်စပ်ကာ ကြိုး၏ ကြိုးပြင်ဘက်ရှိ ကြိုးတန်းများ၏ ခုခံမှုကြောင့် ဖြစ်ပေါ်သော ကြိုးတန်းများ၏ ဆုံးရှုံးမှုများကိုလည်း ထည့်သွင်းတွက်ချက်ရသည်။

I_b = circuit current-carrying capacity

= ကြိုးတန်းမှ ကြိုးတစ်ခုတည်း သို့မဟုတ် ကြိုးများစွာကို ပေါင်းစပ်ထားသော ကြိုးတန်းများ၏ ကြိုးတန်းမှ လျှပ်စီးကို သယ်ဆောင်နိုင်သော စွမ်းရည်

(ကြိုးတန်းမှ ကြိုးတစ်ခုတည်း သို့မဟုတ် ကြိုးများစွာကို ပေါင်းစပ်ထားသော ကြိုးတန်းများ၏ ကြိုးတန်းမှ လျှပ်စီးကို သယ်ဆောင်နိုင်သော စွမ်းရည်)

(၂) Table 5-4 B နှင့် Table 5-4 C တွင် circuit ၏ ကြိုး ကြိုးများ သွားလာနိုင်သော ကြိုးတန်းများ ကြိုးတန်းမှ လျှပ်စီးကို သယ်ဆောင်နိုင်သော စွမ်းရည်များကို Table 5-4 B နှင့် Table 5-4 C တို့တွင် ကြိုးတန်းများ ကြိုးတန်းမှ လျှပ်စီးကို သယ်ဆောင်နိုင်သော စွမ်းရည်များကို

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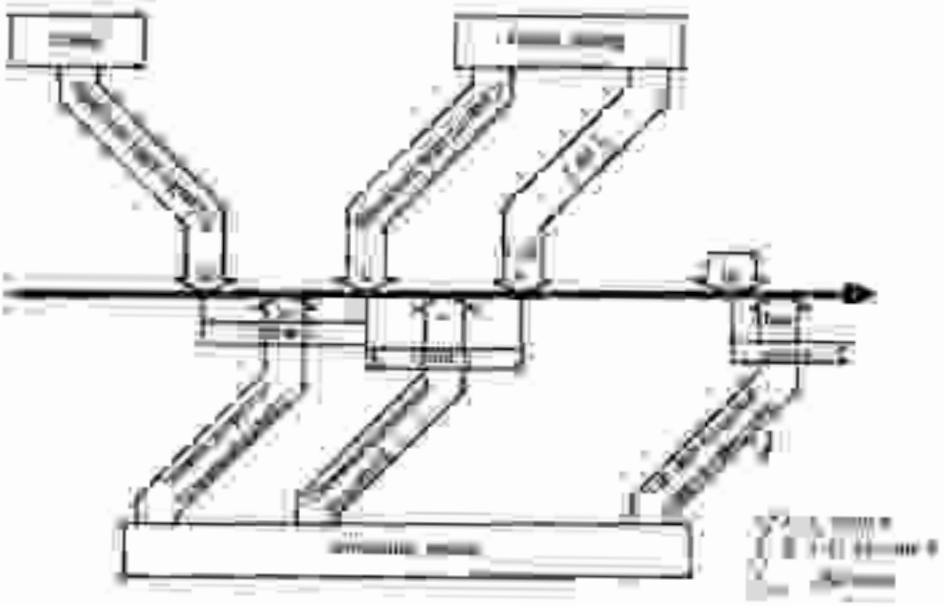

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1. Single Core pvc-insulated Cable, un-armoured without sheath enclosed
BS 6004, BS 6346
Copper conductor
ambient temperature : 30°C
conductor operating temperature : 70°C
current carrying capacity table = Table 4D1A
voltage drop table = Table4D1B

2. multi-core pvc insulated cable, un-armoured cable
BS 6004, BS 6346
copper conductor
ambient temperature: 30°C
conductor operating temperature : 70°C
current carrying capacity table = Table 4D2A
voltage drop table = Table 4D2B

3. Single-core armoured, pvc-insulated cable
(non-magnetic armour)
BS 6346
copper conductor
ambient temperature : 30°C
conductor operating temperature : 70°C
current carrying capacity table = Table 4D3A
voltage drop table = Table 4D3B

4. Multi-core armoured, pvc-insulated cable
BS 6346
copper conductor
ambient temperature : 30°C
conductor operating temperature : 70°C
current carrying capacity table = Table 4D4A
voltage drop table = Table 4D4B

5. Single-core cable having thermosetting insulation (XLPE) non-armoured with or without sheath
BS 5467/BS 6231
copper conductor
ambient temperature : 30°C
conductor operating temperature : 90°C
current carrying capacity table = Table 4E1A
voltage drop table = Table 4E1B

6. multi-core armoured cable having thermosetting insulation (XLPE)
BS 5467
copper conductor
ambient temperature : 30°C
conductor operating temperature : 90°C

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current carrying capacity table= Table 4(2)A
voltage drop table = Table 4(2)B
7 single-core non-armoured cable having thermosetting insulation (xlpe)
(non-sheathed, erased)
BS 5467, BS 6724
copper conductor
ambient temperature : 30°C
conductor operation temperature : 90°C
current carrying capacity table= Table 4(3)A
voltage drop table = Table 4(3)B
8 multi-core armoured cable having thermosetting insulation (xlpe)
BS 5467, BS 6724
copper conductor
ambient temperature 30°C
conductor operation temperature : 90°C
current carrying capacity table= Table 4(4)A
voltage drop table = Table 4(4)B
9 single-core non-armoured cable having 85°C rubber insulation
BS 6007, BS 6883
copper conductor
ambient temperature 30°C
conductor operation temperature : 85°C
current carrying capacity table= Table 4(5)A
voltage drop table = Table 4(5)B
10 multi-core sheathed and non-armoured cable having 85°C rubber insulation
BS 6883
copper conductor
ambient temperature 30°C
conductor operation temperature : 85°C
current-carrying capacity table = Table 4(6)A
voltage drop table =Table 4(6)B
11 single cable in free air of a type (A) (fixed) reducing a overall covering (pvc
BS 6004
copper conductor and earth
ambient temperature 30°C
conductor operation temperature : 70°C
current-carrying capacity table= Table 4(7)A
voltage drop table=Table 4(7)B
12 three insulated cables laid and multi-core cable in free air with earthable
material
BS 6004
copper conductor with earth
ambient temperature 30°C
conductor operation temperature : 70°C
current-carrying capacity table= Table 4(8)A
voltage drop table= Table 4(8)B

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ပြောပြစ်ရသို့ဖြစ်သည်ဟုဆိုလျှင် BS 7671 ပုံဖြင့်ဖော်ပြထားသော Regulation များ

434 PROTECTION AGAINST FAULT CURRENT

434.01 General

434-01-01 A protective device shall be provided in a circuit to break any fault current flowing in that circuit before such current could cause danger due to thermal or mechanical effects produced in those conductors or the associated connections

The prospective fault current at such a protective device may be greater than the current-carrying capacity of the conductors being protected

434-02 Determination of prospective fault current

434-02-01 The prospective fault current under bolted short-circuit conditions at every relevant point of the complete installation shall be determined. This shall be done by either calculation or measurement

434-03 Characteristics of fault current protective devices

434-03-01 Except where the following paragraph applies, the breaking capacity rating of each device shall be not less than the prospective short-circuit fault current at the point at which the device is installed

A lower breaking capacity is permitted if another protective device or devices having the required breaking capacity is installed on the supply side. In this case the characteristics of the devices shall be co-ordinated so that the energy let-through of these devices does not exceed that which can be withstood, without damage, by any device or devices on the load side

434-03-02 Except as follows (see Regulations 434-03-01 and 434-04-01), where an overload protective device complying with Section 433 is to provide short-circuit current protection and of such fault current possible at the point of installation, it may be assumed that the requirements regards fault current protection of the conductors on the load side of that point

The validity of this assumption shall be established, for conductors in parallel and for certain types of circuit-breaker, e.g. non-current limiting types

434-03-03 Where a protective device for fault current protection only, the clearance time of the device under both short-circuit and fault conditions shall not exceed the time limiting temperature of any live conductor being protected

The time at which a given fault current will raise the live conductors from ambient temperature to the limiting temperature can, to a close approximation, be obtained from the formula

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$$I^2 = \frac{k^2 s^2}{t}$$

Where

t is the duration in seconds,

S is the nominal cross-sectional area of conductor in mm²,

I is the value of fault current, in amperes, expressed for a.c. at the r.m.s. value, due account being taken of the current limiting effect of the circuit impedances,

K is the factor taking account of the resistive and temperature coefficients and heat capacity of the conductor material, and the appropriate initial and final temperatures.

522.6 Cables in thermal insulation

522.6.1(i) Where a cable is to be run in a space in which thermal insulation is likely to be applied, the cable shall where practicable be fixed in a position such that it will not be covered by the thermal insulation. Where fixing in such a position is impracticable the cross-sectional area of the cable shall be appropriately increased.

For a cable installed in a thermally insulated wall or above a thermally insulated ceiling, the cable being in contact with a thermally conductive surface on one side, current-carrying capacities are obtained in Appendix 4, Method 4 being the appropriate Reference Method.

(ii) a single-core cable, totally surrounded by thermally insulating material over a length of more than 0.5m, the current-carrying capacity shall be taken, in the absence of more precise information, as 0.5 times the current-carrying capacity for that cable clipped direct to a surface and open (Reference Method 1).

Where a cable is to be totally surrounded by thermal insulation for less than 0.5 m the current capacity of the cable shall be reduced appropriately depending on the size of cable, length of insulation and thermal properties of the insulation. De-rating factors in Table 52A are applicable to cables up to 10mm² in thermal insulation having a thermal conductivity greater than 0.0625 W/K.m

TABLE 52A

Cable surrounded by thermal insulation

Length of insulation (m)	derating factor
0.5	0.59
1.0	0.51
2.0	0.68
4.0	0.53

54 PROTECTIVE CONDUCTORS

543-01 Cross-sectional area

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543-01-03 The cross-sectional area of every protective conductor other than an equipotential bonding conductor, shall be:

(i) calculated in accordance with Regulation 543-01-02, or

(ii) selected in accordance with Regulation 543-01-04,

(including in accordance with Regulation 543-01-03 if necessary) having regard to the value of cross-sectional area of phase conductor as determined by application of Regulation 434-03-03 and to the earth fault current is expected to be less than the fault-circuit current

If the protective conductor:

(iii) [illegible]

(iv) is enclosed by conduit, ducting or trunking, or

(v) is not contained in an enclosure formed by a wiring system,

[illegible] shall be not less than 2.5 mm² copper equivalent, (see also Regulation 543-03-04).

If an earthing conductor buried in the ground Regulation 542-03-01 also applies.

The cross-sectional area of any equipotential bonding conductor shall comply with Section 547

543-01-02 Where a protective conductor is common to several circuits, the cross-sectional area of the protective conductor shall be:

(i) calculated in accordance with Regulation 543-01-02 for the most onerous of the values of fault current and operating time determined for each of the circuits concerned, or

(ii) selected in accordance with Regulation 543-01-04 so as to correspond to the cross-sectional area of the largest phase conductor of the circuits.

543-01-03 The cross-sectional area, where calculated, shall be not less than the value determined by the following formula or shall be obtained by reference to BS 7454:

$$S = \frac{\sqrt{I^2 t}}{k}$$

Where:

S is the nominal cross-sectional area of the conductor in mm²

I is the value in amperes (rms for a.c.) of fault current for a fault of negligible impedance which can flow through the associated protective device, due account being taken of the current limiting effect of the circuit impedances and the limiting capability (I²t) of the protective device

A must [illegible] in the effect, on the [illegible] of overcurrent protective devices, of their temperature during the flow of the fault

t is the operating time of the disconnecting device in seconds corresponding to the fault current I, taken

[illegible] account of the resulting temperature conferred and heat capacity of the conductor material, and the appropriate initial and final temperatures.

$$\sqrt{I^2 t} = kS$$

1. The [illegible] calculation [illegible]

2. The most [illegible] calculation does obtain:

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1. IEE wiring regulations, BS 7671 | regulations for electrical installations, sixteenth edition (1991)
2. IEE on-site guide BS 7671 2001 (2004)
3. Electrical installation guide 2008, schneider-electric
4. power guide 2009, legrand
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6. Principles and design of low voltage system, ivm power publication (Singapore)

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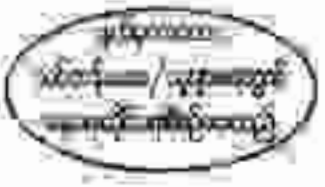
- Measuring (mm) [illegible] Welding Density [illegible]
- ISO Standard [illegible]



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